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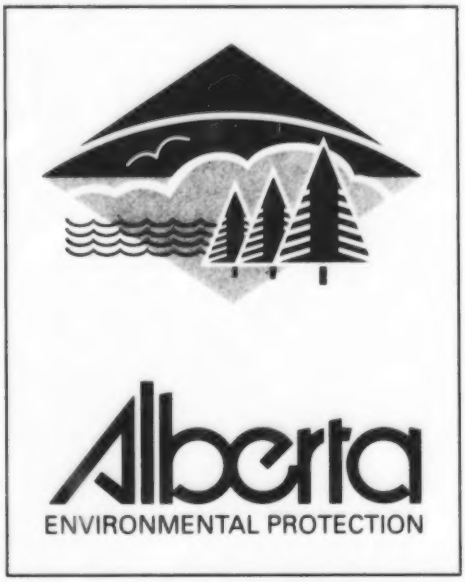
Environmental Guidelines for the Review of Subdivisions in Alberta



September 1998

Standards and Guidelines Branch
Environmental Assessment Division
Environmental Regulatory Service

A subdivision authority may request that an applicant supply information on site conditions. This request is supported by a number of provisions of the *Subdivision and Development Regulation, Municipal Government Act*. Site information assists a subdivision authority to determine whether or not the land to be subdivided is suitable for the purpose for which the subdivision is intended. These environmental guidelines greatly expand on the brief references to environmental problems found in the regulation. They provide an opportunity for greater understanding of various environmental conflicts, identify steps that a subdivision authority may take, and instruct consultants on how to prepare an environmental report.

Additional copies of the environmental guidelines may be obtained by contacting:

Information Centre - Alberta Environment
Main Floor, 9920 - 108 Street
Edmonton, AB T5K 2M4

Phone (403) 422-2079
Email: env.infocent@gov.ab.ca

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POSTSCRIPT

The primary author of these environmental guidelines is Richard Bramm, who was a member of the former Standards and Guidelines Branch, Alberta Environmental Protection. These guidelines reflect information that was verified as accurate at the time of final editing, September 1998. Users of these guidelines are responsible for ensuring their actions are in compliance with current provincial and municipal legislation and policy.

For a variety of reasons, Alberta Environment has shifted its focus over the years away from the review of individual subdivision applications and the development of associated environmental guidelines. While Alberta Environment has no plans to finalize the environmental guidelines found herein, the Department believes that the information contained in this draft is valuable and should be placed in the public domain.

September 1999

Environmental Guidelines for the Review of Subdivisions in Alberta
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Chapter 1 – Introduction to the Guidelines

A. *Origin and Development of the Guideline Report*

Since the 1970's, the Department has been writing guidelines supporting the environmental review of subdivision applications. The original two guidelines dealt with the evaluation of groundwater supply for single family residences, and the examination of soil characteristics as they related to private sewage disposal systems. In 1994, four Interim Guidelines were published, the first two replacing and updating the original ones. The two new 1994 guidelines discussed the environmental impacts to subdivisions by river flooding and erosion, and slope movements on steep valley banks.

The present guideline report replaces and updates all four 1994 Interim Guidelines and adds a new guideline on Lake Residential Subdivisions. The report also contains eight supporting appendices. This report is closely related to the *Environmental Reference Manual for the Review of Subdivisions in Alberta* published in November 1996. Many changes have been made to the older guidelines. Revisions have been necessary to recognize the provisions of the new *Municipal Government Act* and associated *Subdivision and Development Regulation*, and the *Water Act* that have replaced the *Planning Act* and *Subdivision Regulation*, and the *Water Resources Act*. Furthermore, alterations have been undertaken to reflect the current Department organization. Finally, in some cases, the technical aspects of the older guidelines have been modified based upon new information.

B. *Relationship of the Guidelines with the Municipal Government Act and the Subdivision and Development Regulation*

The *Municipal Government Act* provides that in deciding on a subdivision application, a subdivision authority, must not approve an application unless the land is suitable for the purpose for which the subdivision is intended. Environmental concerns play a key role in determining the suitability of land for a particular use.

A number of provisions of the *Subdivision and Development Regulation, Municipal Government Act* support requests by a subdivision authority for information on site conditions. This information assists a subdivision authority to determine whether or not the land to be subdivided is suitable for the purpose for which the subdivision is intended. These environmental guidelines greatly expand on the brief references to environmental problems found in the regulation. They provide an in depth understanding of various environmental conflicts, recommended steps that a subdivision authority take, and detailed instructions to consultants for the preparation of an environmental report.

C. *Other Uses of the Guidelines*

While the Guidelines focus on the review of subdivision applications, users will find the Guidelines helpful with respect to the environmental aspects of development reviews and as a reference document for the preparation of land use plans. Moreover, these Guidelines will assist users to pinpoint when a proposed development will likely require environmental approvals or authorizations pursuant to the *Water Act* and/or the *Public Lands Act*.

D. *Referencing these Guidelines as a Source*

Whenever any part of these Guidelines are used or referred to in a report or presentation, users are requested to acknowledge this report as the source.

E. *Summary of Chapters and Appendices*

The report is divided into a number of chapters and appendices. Where applicable, links to other relevant guidelines or appendices are identified within the chapters.

- Chapter 1 - introduction
- Chapter 2 - groundwater supply
- Chapter 3 - soils and sewage disposal
- Chapter 4 - river flooding and erosion
- Chapter 5 - valley bank hazards
- Chapter 6 - lake residential subdivisions
- Appendix A - environmental references in the *Municipal Government Act*.
- Appendix B - environmental references in the *Subdivision and Development Regulation*
- Appendix C - *Land Use Policies*
- Appendix D - selected references from the *Water Act*
- Appendix E - glossary
- Appendix F - background on selected environmental topics
- Appendix H - preparation of a base map

F. *Limitations*

The Department of Environmental Protection does not accept any responsibility for the user's use or interpretation of these guidelines. In the event of conflict between these guidelines and any legislation, it is the user's responsibility to interpret and act in compliance with the legislation.

Chapter 2 – DRAFT Guidelines for the Evaluation of Groundwater Supply for Unserviced Residential Subdivisions

A. *Introduction*

i. Revision of the June 27, 1994 Guidelines

These guidelines replace and update the June 27, 1994 *Interim Guidelines for the Evaluation of Groundwater Supply for Unserviced Residential Subdivisions Using Privately Owned Domestic Water Wells.* The Standards and Guidelines Branch has made many revisions to the 1994 guidelines to recognize the provisions of the new *Municipal Government Act* and associated *Subdivision and Development Regulation*, and the *Water Act* that have replaced the *Planning Act* and *Subdivision Regulation*, and the *Water Resources Act*.

ii. Focus of these Guidelines

Like the 1994 guidelines, these guidelines provide a method to establish whether each lot within a proposed unserviced residential subdivision will have an adequate groundwater supply, and whether the subdivision's household water diversions will interfere with the water supply of existing users (Glossary – Suitable Development Area of an Unserviced Residential Lot).

Groundwater resources vary across the province and even local differences can be extreme. The threat of groundwater shortages and contamination grows with the density of wells and their collective demand on the local groundwater resources (for details refer to *Water Wells that last for generations 1998* listed in Appendix F, Section B. Water Supply). As a consequence, there should be a carefully considered match between a proposed unserviced residential subdivision using groundwater and the characteristics of the local supply. Use of these guidelines at the time of subdivision will help to ensure that this vital resource is maintained for the diverse needs of today and the requirements of future.

A subdivision authority may take measures to avoid or mitigate water supply problems within the Proposed Subdivision Area and associated Titled Area. The subdivision authority may modify the subdivision lot design by reducing lot density or eliminating development in areas deficient in groundwater resources.

iii. Relationship of these Guidelines to Provincial Acts and Regulations

These guidelines are tied to environmental provisions in the *Municipal Government Act* (refer to Appendix A for complete list), its *Subdivision and Development Regulation* (see Appendix B) and *Land Use Policies* (Appendix C), and the *Water Act* (Appendix D).

According to section 654(1)(a) of the *Municipal Government Act* "A subdivision authority must not approve an application for subdivision approval unless the land that is proposed to be subdivided is, in the opinion of the subdivision authority, suitable for the purpose for which the subdivision is intended". These guidelines assist in evaluating the environmental suitability of a proposed subdivision, specifically with respect to the availability of an adequate groundwater supply for each unserviced lot and associated household.

Many provisions within Part 1 - Subdivision Applications, of the *Subdivision and Development Regulation, Municipal Government Act* support requests by a subdivision authority for information on water supply (Appendix B; for these guidelines refer to section 4(4)(g), section 4(5)(b), and section 7(f) of the Regulation). Section 4(5)(b) is especially relevant to these guidelines and deals with the case where the proposed subdivision is not to be served by a water distribution system. Specifically, this subsection states that the subdivision authority may require an applicant for subdivision to submit a report by a qualified person, respecting the provision, availability and suitability of potable water on or to the land to be subdivided.

This water supply information will assist a subdivision authority to decide whether the land to be subdivided is suitable for the purpose for which the subdivision is intended (section 654(1)(a) of the *Municipal Government Act*; refer to Appendix A.I.).

The *Land Use Policies* (Appendix C) established by the Lieutenant Governor in Council pursuant to Section 622 of the *Municipal Government Act* (Appendix A, Section F.) contains a number of goals and policies relevant to these groundwater supply guidelines. In this regard refer in particular to section 3.0 Planning Co-operation, policy 7.; section 4.0 Land Use Patterns, policy 2.; section 5.0 The Natural Environment; section 6.3 Resource Conservation – Water Resources; and Appendix 1.

These guidelines are consistent with the purpose of the *Water Act*, particularly with subsections 2(a)(b)(c) and (d).

2 The purpose of this Act is to support and promote the conservation and management of water, including the wise allocation and use of water, while recognizing

(a) the need to manage and conserve water resources to sustain our environment and to ensure a healthy environment and high quality of life in the present and the future;

(b) the need for Alberta's economic growth and prosperity;

(c) the need for an integrated approach and comprehensive, flexible administration and management systems based on sound planning, regulatory actions and market forces;

(d) the shared responsibility of all residents of Alberta for the conservation and wise use of water and their role in providing advice with respect to water management planning and decision-making;

Sections 1(1)(y), 21 and 23 of the *Water Act* (Appendix D, Sections B., F. and H.) are especially relevant to these guidelines. Section 1(1)(y) defines "household purposes" as the use of a maximum of 1250 cubic metres of water per year per household for the purposes of human consumption, sanitation, fire prevention and watering animals, gardens, lawns and trees. Section 21 addresses the various aspects of the diversion of water for household purposes. Section 23(3)(a) discusses the preparation of a water supply report certified by a qualified consultant. This report must be submitted to the subdivision authority as part of the subdivision application. According to this subsection, each household within the proposed subdivision has the right to commence and continue to divert water for household purposes only if the report shows that each of these households can divert 1250 cubic metres of water per year for household purposes without interfering with existing users (other household users, licensees, or traditional agriculture users). Section 23(3)(b) states that this water diversion must be consistent with an applicable approved water management plan (Appendix D, Sections C., D., E. and H.).

With respect to sections 1(1)(y) and 23, it can be safely assumed that with few exceptions there will be only one household per subdivided lot. The maximum household water diversion rate of 1250 cubic metres per year per household is equivalent to 1250 m^3/year/lot, 3.42 m^3/day/lot, about 753 imperial gallons per day per lot (igpd/lot) or 0.52 imperial gallons per minute per lot over a 24 hour period (igpm/lot).

Based upon the above, the water supply reports described in the *Subdivision and Development Regulation* and the *Water Act* have a different but complementary emphasis. In the *Subdivision and Development Regulation* the focus is on the provision, availability and suitability of potable water for the proposed subdivision and its lots. In contrast, the *Water Act* concentrates on the potential that the subdivision's household water diversions may interfere with the water supply of existing users.

iv. Who Should Use these Guidelines and Under What Circumstances?

Subdivision authority planners and a developer's consultants will likely be the major users of these Guidelines. Individual lot owners may also find them informative.

If a proposed residential subdivision will derive its water supply from privately owned water wells, a Residential Subdivision Groundwater Supply Report certified by a qualified consultant is required pursuant to section 23(3) of the *Water Act* (Appendix D, Sections H.).

Ideally, a developer's planning, surveying and groundwater consultants will use these guidelines before submitting the subdivision application and tentative plan to the subdivision authority.

B. *Perspectives on Proposed Residential Subdivisions that will not be connected to a Municipal Waterworks System*

i. Introduction

Frequently it is unfeasible to connect a proposed residential subdivision to a municipal waterworks system. There remains a number of alternatives for supplying the subdivision with water. The subdivision may use of a central water well or surface water supply connected to a piped water distribution system (surface water is obtained from a natural water body such as a river, stream or lake). On the other hand, the household in each subdivided lot may have its own household water supply system.

A household water supply system may be based upon hauled water and a cistern, a surface water supply or a water well. Sections 21(1) and 21(2) of the *Water Act* (Appendix D, Sections F.) recognize that a person who owns or occupies land that adjoins a natural water body or under which groundwater exists has the right to commence and continue the diversion of water for household purposes. For household systems using surface water or groundwater for household purposes, section 1(1)(y)) of the *Water Act* (Appendix D, Section B.) specifies that a household can use up to a maximum of 1250 cubic metres of water per year. These purposes include human consumption, sanitation, fire prevention, and watering animals, gardens, lawns and trees.

ii. Proposed Water Supply Systems for Small Municipal Developments

Proposed water supply systems for small municipal developments will likely require approvals or authorisation pursuant to the *Environmental Protection and Enhancement Act*, the *Water Resources Act* and possibly the *Public Lands*. The following two guidelines provide information for these water supply systems.

- *Standards and Guidelines for Municipal Water Supply, Wastewater and Storm Drainage Facilities (December 1997)* (available for purchase from the Queen's Printer Bookstore; refer to Appendix F, Section A. for addresses and telephone)

- *Guidelines for the Design and Approval of Water Supply Systems For Small Municipal Developments (August 1986)* (currently under review; available from the Standards and Guidelines Branch, Alberta Environmental Protection – Edmonton, 427-8664

Specific questions regarding Alberta Environmental Protection's approvals process and requirements may be directed to the nearest Natural Resources Service regional office (private callers within Alberta can phone the Regional Information Telephone Enquiry RITE Number 310-0000 to connect toll free to these numbers).

• Bow Region	Calgary office - Phone 297-6582
• Northeast Boreal Region	Edmonton office - Phone 427-5296
• Northern East Slopes	Edmonton office - Phone 427-8283
• Northwest Boreal Region	Peace River office - Phone 624-6237
• Parkland Region	Red Deer office - Phone 340-5310
•	Leduc office - Phone 986-6286
• Prairie Region	Lethbridge office - Phone 381-5995

iii. Hauled Water/Cistern Household Water Supply System

Information on hauled water/cistern household water supply system may be obtained within the *Nuisance and General Sanitation Regulation, Alberta Regulation 242/85, Public Health Act* (refer to Appendix F, Section A. - Queen's Printer Bookstores).

iv. Surface Water and Water Well Based Household Water Supply Systems

Where it is unfeasible to connect a proposed subdivision to a municipal waterworks system, it is recommended if it is possible, that each lot and associated household have its own water well. This groundwater supply option is favoured over a surface water supply since it is less likely to require treatment. Use of a water well based household water supply system is also preferred over a small municipal development type water supply system or the use of a hauled water/cistern supply system since it:

(1) is consistent with rural self-sufficiency;

(2) promotes water conservation;

(3) likely will remain the complete responsibility of the individual lot owner and not the municipality;

(4) likely has lower capital, operation and maintenance costs than alternative methods;

(5) likely has the most predictable costs over the long term; and

(6) likely is the most energy efficient.

C. *Preparation of a Subdivision Groundwater Supply Report by a Qualified Groundwater Consultant*

i. Hiring a Qualified Groundwater Consultant

If these guidelines apply, it is the applicant's responsibility to select and hire a qualified groundwater consultant to prepare and certify a Subdivision Groundwater Supply Report. The consultant must be a professional engineer, professional geologist or professional geophysicist (as defined in the *Engineering, Geological and Geophysical Professions Act*), whose area of competence lies within the groundwater field, and who is a member of APEGGA (Association of Professional Engineers, Geologists & Geophysicists of Alberta).

Consultants may be found in the Yellow Pages under Engineers Consulting, Engineers Environmental or Environmental Consultants (see either the phone book or Telus Advertising Services' website – On-line Yellow Directories & Interactive Services http://www.alberta.com/). The Environmental Services Association of Alberta also has a lengthy directory of environmental consultants (phone 1-800-661-9278 or view the association's website at http://www.esaa.org).

If a consultant is an engineer or geologist, an applicant can determine whether the consultant is a member in good standing with the Association of Professional Engineers, Geologists & Geophysicists of Alberta (APEGGA) by contacting APEGGA (Edmonton, 426-3990).

ii. Three Major Objectives of the Subdivision Groundwater Supply Report

Consistent with Section A.iii., the three major objectives of the Subdivision Groundwater Supply Report reflect the different but complementary emphases of the *Subdivision and Development Regulation* and the *Water Act*.

(1) Quantity and Quality of Groundwater Available to Households within the Proposed Subdivision

The first objective of the report is to assess the potential that one or more aquifers (Glossary) underlying the Proposed Subdivision Area, if any one is present, can supply groundwater for household purposes to each proposed lot and associated household during peak demand periods and over the long term. Each household would have its own water well.

As discussed in Section A.iii. and B.i., according to section 1(1)(y) of the *Water Act*, household purposes means the use of a maximum of 1250 cubic metres of water per year per household for the purposes of human consumption, sanitation, fire prevention, and watering animals, gardens, lawns and trees. With respect to the evaluation of groundwater quantity, the report should address the extent to which each aquifer is continuous beneath the Proposed Subdivision Area (depending upon the distribution of each aquifer, each household may not be able to have its own water well).

Since the groundwater will be used for household purposes as defined above, the report must consider the quality of each aquifer's water in its current state taking into account its natural quality and possible existing anthropogenic (Glossary) contamination (refer to the local Regional Health Authority's criteria for potable water). If the groundwater requires treatment to make it potable, the report should estimate whether treatment is feasible. Furthermore, the report should examine the potential susceptibility of each aquifer to being contaminated bearing in mind aquifer depth and the perviousness of overlaying layers (perviousness is influenced by composition, and presence of fractures, fissures or cracks). One of the primary sources of contamination is sewage effluent generated by each household's on-site private sewage disposal system.

(2) Potential Interference with Existing Groundwater Users

The second objective of the report is to assess the potential that household groundwater diversions resulting from the proposed subdivision may interfere with any household users, licensees or traditional agriculture users who exist when the subdivision is approved (Appendix D, Section H.).

(3) Consistency with an Applicable Approved Water Management Plan

The third objective of the report is to assess whether the household groundwater diversions resulting from the proposed subdivision will be consistent with an applicable approved water management plan (Appendix D, Section H.).

iii. Preparation of the Subdivision Groundwater Supply Report - General

The report contains several components. Aquifer testing may be a component depending upon the availability of existing hydrogeological information. The report should include all information specified in Section D. (driller's reports, tables, maps, cross-sections, etc.) and, if applicable, Section E. Aquifer Testing.

(1) Collection, Summary and Assessment of Existing Local Groundwater Data

The consultant should collect and summarize in the report existing local groundwater data as described in Section D. for an area termed the Evaluation Area which includes the Proposed Subdivision Area and surrounding land within a minimum of 3.2 km (2 miles) from the subdivision boundary.

The consultant should assess whether there is sufficient existing hydrogeological information to achieve the three major objectives of the report (Section C.ii.). This assessment should be presented in the report.

(2) Aquifer Testing if Existing Local Groundwater Data Insufficient

If the consultant determines there is insufficient hydrogeological information to achieve the three major objectives of the report (Section C.ii.), the consultant should conduct upon the consent of the developer, one or more aquifer tests according to the procedure set forth in Section E.

The description of the aquifer test and the interpretation of the aquifer test data should be presented in the report as per Section E. Knowledge of the local hydrogeological setting gained from the first step can help identify site specific requirements for aquifer testing, and assist with the interpretation of aquifer test results.

(3) Three Major Conclusions

Based upon the results from Step (1) and/or Step (2), and reflecting the three major objectives of the report (Section C.ii.), the consultant should clearly state in the conclusion of the report:

(a) whether groundwater underlying Proposed Subdivision Area can supply water for household purposes to each proposed lot and associated household during peak demand periods and over the long term (where each household has its own water well; each household can use a maximum of 1250 cubic metres of water per year);

(b) whether the diversion of 1250 cubic metres of water per year for household purposes under section 21 of the *Water Act* for each of the households within the subdivision will interfere with any household users, licensees or traditional agriculture users who exist when the subdivision is approved; and

(c) whether the diversion of groundwater by the proposed subdivision's households is consistent with an applicable approved water management plan.

(4) Quality Assurance Statement in the Report

The subdivision authority needs high quality, trustworthy information to make a good decision. A poor study may result ultimately in residential lots that have poor developability due to a lack of groundwater resources; or the groundwater supply of existing users being jeopardized. To help ensure that the study is of professional quality, the consultant and any reviewers must sign and stamp the work and include a Quality Assurance Statement. The statement should assure the subdivision authority that the consultant has performed the evaluation in conformance with these guidelines.

If the report has not followed Steps (1) through (3) above and/or does not contain a Quality Assurance Statement, the subdivision authority should identify this as a major deficiency and not proceed with the application until this has been remedied.

(5) Submission of the Report to the Subdivision Authority and the Water Data Management Section

The applicant should submit copies of the Subdivision Groundwater Supply Report to the subdivision authority. The authority will need at least one copy for its own use and one for circulation to the municipality (if applicable).

The applicant should also send a copy of the report to the Water Data Management Section, Water Sciences Branch (refer to Appendix G., Section D., item (7)). This section is the provincial repository for groundwater and surface water information.

D. *Collecting, Summarising and Evaluating Existing Hydrogeological Information within the Evaluation Area*

i. Purpose

The purpose of this component of the Subdivision Groundwater Supply Report is to have a qualified groundwater consultant (Section C.i.) collect, summarize and evaluate existing hydrogeological information within the Evaluation Area. This area includes the Proposed Subdivision Area and surrounding land within a minimum of 3.2 km (2 miles) from the subdivision boundary. The consultant should address whether there is sufficient existing hydrogeological information to achieve the three major objectives of the report (Section C.ii.). If there is, the consultant should determine relative to these objectives the implications for the proposed subdivision.

ii. Sources of Groundwater Information

Water supply related Alberta guidelines and reference to the publication *Water Wells that last for generations* 1998 are located in Appendix F, Section B., Water Supply. Sources for air photos, maps and reports of interest to groundwater consultants may be found in Appendix G, Section D., Sources of Information for Mapping and Site Investigations.

iii. Water Well Survey and Groundwater Data Summary within the Evaluation Area

A more detailed assessment of aquifer potential should be undertaken using water well driller's reports and all other hydrogeologic data available for the Evaluation Area. Information from the driller's reports should be summarized through a combination of text, tables, maps, cross-sections and other drawings. The summary should include the following information for the Evaluation Area:

(1) a map showing all field verified well locations and springs;

(2) ground elevation (actual or estimated) of all wells and springs;

(3) well construction details;

(4) lithologic logs, well depths, static water levels, well yields and spring discharge rates;

(5) depth, thickness, lithology, extent and type (confined or unconfined) of any aquifers available to the proposed development;

(6) aquifer coefficients (transmissivity, theoretical 20 year safe yield) based on existing well information;

(7) chemical analyses of well water;

(8) hydrogeologic cross-sections; and

(9) legible copies of all water well driller's reports pertinent to the Evaluation Area.

A field inspection of the Evaluation Area is recommended to verify well locations (refer to point 1), topographic conditions, well water levels, water chemistries, etc.

E. Aquifer Testing

i. Purpose

If there is insufficient existing hydrogeological information (Section D.) to achieve the three major objectives of the Subdivision Groundwater Supply Report (Section C.ii.), a qualified groundwater consultant (Section C.i.) should conduct upon the consent of the developer, one or more aquifer tests. Although aquifer testing may be necessary, it is important to recognize the value of the survey conducted in Section D. Knowledge of the local hydrogeological setting can help identify site specific requirements for aquifer testing, and assist with the interpretation of aquifer test results.

The purpose of this section is to describe the various facets of the aquifer testing procedure and the type of description and analysis that the consultant should include in the report.

ii. General Description of Aquifer Testing

The aquifer testing procedure outlined in this section involves the use of at least one production well pumped at a constant rate for a **minimum of 24 hours**. A detailed description of the test, interpretation of the test results in light of the local hydrogeological setting, analysis of water quality and recommendations should be included in the Subdivision Groundwater Supply Report.

Prior to undertaking aquifer testing the consultant should contact the nearest Natural Resources Service regional office for an Exploration Permit (refer to Section B.ii.). A copy of the Permit should be included in the report.

• Bow Region	Calgary office - Phone 297-6582
• Northeast Boreal Region	Edmonton office - Phone 427-5296
• Northern East Slopes	Edmonton office - Phone 427-8283
• Northwest Boreal Region	Peace River office - Phone 624-6237
• Parkland Region	Red Deer office - Phone 340-5310
•	Leduc office - Phone 986-6286
• Prairie Region	Lethbridge office - Phone 381-5995

iii. Aquifer Tests – Possible Use of More than one Production Well

More than one production well may be needed to properly evaluate the groundwater supply potential for a proposed residential subdivision because of well interference, aquifer discontinuity, marginal groundwater supply, the extent of the Proposed Subdivision Area and/or the distribution of existing neighbouring groundwater users.

iv. Use of an Existing Well as a Production Well

For a proposed residential subdivision situated within a quarter section, an existing well may be used as a production well if it meets the following criteria:

(1) There is sufficient information, including all well construction details, lithologic log and depth of the production zone available to properly interpret the aquifer test results.

(2) The existing well is completed in the same aquifer as the one likely to be used by the prospective residents of the proposed parcels.

(3) All of the proposed residential parcels are within 805 metres (1/2 mile) of this well.

Of the existing wells that meet these criteria, those at or near the centre of the proposed subdivision are strongly preferred; however, more distant wells in the quarter section or adjacent quarter sections may also be considered.

If the proposed residential subdivision extends beyond a single quarter section, the proposed development on each quarter section must be treated as if it was a separate subdivision and the well selection criteria set forth above utilized. In some cases, additional production wells may be necessary.

v. Use of New Wells as Production Wells

If existing well(s) cannot be employed, then new well(s) must be drilled at or near the centre of the Proposed Subdivision Area, and developed. If the proposed subdivision is of a large size and extends beyond a single quarter section, more than one production well may have to be used (refer to preceding subsection). If more than one aquifer is present, steps should be taken to ensure that waters from

different aquifers do not mix via the well bore, or multiple openings along casings or pipes.

vi. Possible Use of Observation Wells

Depending upon the circumstances the consultant may decide that one or more observation wells should be used to assess the degree to which the aquifer being tested by the production well is continuous beneath the proposed subdivision (refer to Section C.ii., Objective (1)). An observation well should generally be located at a distance of 15 metres (50 feet) to 152 metres (500 feet) from the production well and be completed in the same aquifer. The distance between the production well and an observation well should be at least 1.5 times the aquifer thickness.

vii. Detailed Description of Aquifer Test

This component of the Subdivision Groundwater Supply Report should contain detailed information on each aquifer test of an existing or new well. This should include well construction details, lithologic logs, aquifer test description, water level measurements, and interpretation of results including any graphical data plots and a chemical analysis. Methods of obtaining information described below are flexible as field conditions and professional judgement should dictate the consultant's approach to aquifer evaluation.

(1) Construction Details of Each Well

Details are required on the construction of each production and observation well involved in aquifer testing. This includes the length and diameter of all casing, liners, seals, and descriptions of all fittings, pumps, screens, filter packs and other materials used in constructing each well. In addition, details of the method and the length of time each well was developed should be included.

(2) Detailed Lithologic Logs of Each Well

Detailed lithologic logs of each well are essential in order to delineate potential water-bearing zones, and to correlate the subsurface geology between adjacent wells or test holes. A detailed lithologic log should therefore note variations in lithology, texture, hardness, colour, moisture, plasticity, stability of the unsupported bore wall, and any other noteworthy physical characteristics of the material being penetrated. Due to the inherent difficulty in obtaining samples from deeper levels with most types of drilling equipment, electric logs (resistivity, spontaneous potential) and gamma logs are invaluable aids in distinguishing the depth of lithologic variations and in determining aquifer thickness.

(3) Aquifer Test Description

The aquifer test must consist of a minimum of 24 hours pumping and 24 hours recovery unless 90% recovery has been attained before the end of the recovery phase. The consultant in the field may extend the duration of an aquifer test beyond the minimum to obtain more reliable aquifer parameters for the determination of an accurate 20-year safe yield. This is recommended if the proposed lot density exceeds 40 parcels per quarter section. In addition, regardless of lot density, a longer test may be necessary due to hydrogeologic factors such as barrier boundaries or fracture permeability (groundwater movement through fractures as well as pores). These factors may be suspected in the area or detected during aquifer testing (in this case the rate of water level decline increases substantially during the latter part of the test: **the test should be continued until a trend is firmly established**).

The pumping rate at which the test is conducted should be held constant. The rate should be at least **twice the average production rate** required to supply the proposed subdivision. Calculated theoretical 20-year safe yields that are significantly greater than the pumping rate maintained during the aquifer test are considered unreliable. A step drawdown test helps determine a suitable pumping rate for the constant-rate aquifer test.

There are a number of natural factors that can cause deflections in the time-drawdown curve such as boundary effects, fracture permeability, dewatering in water table aquifers and continual development of the well. As it can be difficult to separate these effects from one another, it is crucial that the pumping rate variation be maintained at less than 5% by constant monitoring. The actual pumping rate (or pressure readings on a flow restrictor) should be documented every 10 minutes for the first hour of pumping. After one hour, readings should be taken at the time of drawdown measurements (refer to Subsection 4 for times). The level at which the pump is set within the production well should also be documented.

(4) Schedule of Water Level Measurements

Water level measurements of the production well(s) (and observation well(s) if utilized) should be recorded to the nearest 1.0 cm during pumping and recovery phases of the aquifer test in order to properly evaluate aquifer test results. Both the pumping and recovery phases should be of equal duration unless 90% recovery has been attained before the end of the recovery phase. The following time schedule should be used for taking drawdown and recovery measurements.

Pumping and Recovery Measurement Time Schedule Table

1 to 10 minutes	every minute
10 to 30 minutes	every 5 minutes
30 to 60 minutes	every 10 minutes
1 to 2 hours	every 15 minutes
2 to 4 hours	every 30 minutes
4 to 12 hours	every hour
12 to 24 hours	every 2 hours
24 to 36 hours	every 4 hours
36 to 48 hours	every 6 hours
more that 48 hours	every 8 to 12 hours

(5) Interpretation of Aquifer Test Data

The Cooper and Jacob Method (1946) of aquifer evaluation is a common method used for determining aquifer characteristics and establishing the theoretical long-term yield of water wells. This method simplifies the calculation of aquifer coefficients by reducing the relationship between transmissivity (T), pumping rate (Q), and drawdown (s) to the following:

$$T = \frac{2.3\,Q}{4\pi\Delta s} \quad (1)$$

$$= \frac{0.183Q}{\Delta s} \quad (2)$$

where T is the coefficient of transmissivity of the aquifer in m^2/day, Q is the constant pumping rate in m^3/day, and Δs is the slope of the time-drawdown graph expressed as the change in drawdown in metres between any two times on the log scale whose ratio is 10 (one log cycle).

The theoretical 20-year safe yield (Q_{20}) of the well can then be determined by using the formula:

$$Q_{20} = (0.68)\,(T)\,(H)\,(0.7)$$

where T and Q are as defined in equation (1) and H is the available head. The 20 year safe yield represents the continuous pumping at that rate for 20 years at the end of which the water level in the well is projected to have reached the top of the aquifer.

For confined aquifers, H is the distance between the top of the aquifer, or the top of the production interval, whichever is less, and the static or pre-pumping water level in the well. For unconfined aquifers, H is arbitrarily chosen as 2/3 of the elevation difference between the base of the aquifer and the static water level. An arbitrary safety factor of 0.7 is included into the 20-year safe yield determination.

Another variation of the 20-year yield calculation is commonly used where extreme well losses are encountered.

$$Q_{20} = \frac{(Q)(H)}{s_{10} + 6\Delta s} \qquad (4)$$

In this instance, Q, H, and Δs are as previously defined and s_{10} is the drawdown at 10 minutes.

The formulae presented in these guidelines are the most commonly used for determining the theoretical long term yield of domestic wells. Alternative methods of evaluation may also be acceptable. Any reasonable mathematical evaluation method that best fits the test results may be used to obtain aquifer characteristics such as Transmissivity (T), Storativity (S), Hydraulic Conductivity (K), and to calculate the long term safe yield (i.e. Q_{20}). In such cases the consultant should provide the reasons for the choice of method(s) of evaluation, the assumptions made and references.

(6) Assessment of Potential Interference with other Groundwater Users

Pursuant to section 23(3)(a) of the *Water Act*, the groundwater consultant should assess whether the diversion of 1250 cubic metres of water per year for household purposes under section 21 of the *Water Act* for each of the households within the subdivision will interfere with any household users, licensees or traditional agriculture users who exist when the subdivision is approved.

(7) Chemical and Bacteriological Analyses

Towards the end of an aquifer test, a water sample should be obtained for chemical analysis. Samples should be taken in clean containers about one litre in size and should be analysed as soon as practical after sampling. Samples should not be allowed to freeze or be subjected to excessively high temperatures or sunlight. Samples containing sediment (suspended or settled) should be filtered immediately upon withdrawal from the well. All water samples must be treated and analysed in accordance with the local Regional Health Authority's requirements.

Containers for water samples collected for bacteriological analysis, together with sampling procedures and submission requirements may be obtained from the local Regional Health Authority. Should any questions arise concerning the interpretation of the results of these analyses, the local Public Health Inspector should be contacted.

Chapter 3 – Guidelines for the Evaluation of Water Table Conditions and Soil Percolation Rate for Unserviced Residential Subdivisions

A. Introduction

i. Revision of the April 26, 1994 Guidelines

These guidelines replace and update the April 26, 1994 *Interim Guidelines for the Evaluation of Water Table Conditions and Soil Percolation Rate for Unserviced Residential Subdivisions*. The Standards and Guidelines Branch has made numerous revisions to the 1994 guidelines to recognize the provisions of the new *Municipal Government Act* and associated *Subdivision and Development Regulation* that have replaced the *Planning Act* and *Subdivision Regulation*. However, it will be observed that the technical aspects of the 1994 guidelines relating to the evaluation of water table conditions and soil percolation rate have not been changed substantially.

ii. Focus of these Guidelines

These guidelines help to establish whether each proposed unserviced residential lot has a Suitable Development Area (Glossary) especially with respect to:

- the potential for long term, satisfactory on site sewage disposal and treatment (unsuitable soil conditions may cause private sewage disposal systems to malfunction thereby contaminating surface and/or groundwater); and
- the potential for interference with site development (building foundations and an access road) due to high water table conditions.

In addition, these guidelines assist in the identification of areas within the Proposed Subdivision Area and associated Titled Area that are swampy (wetlands; permanently high water table conditions). These low areas could potentially be set aside as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

iii. Relationship of these Guidelines to Provincial Acts and Regulations

These guidelines are tied to environmental provisions in the *Municipal Government Act* (Appendix A for complete list), its *Subdivision and Development Regulation* (Appendix B), the *Plumbing Code Regulation* and the *Environmental Protection and Enhancement Act*.

According to section 654(1)(a) of the *Municipal Government Act* "A subdivision authority must not approve an application for subdivision approval unless the land that is proposed to be subdivided is, in the opinion of the subdivision authority, suitable for the purpose for which the subdivision is intended." These guidelines assist in evaluating the environmental suitability of a proposed subdivision, specifically with respect to soils and sewage disposal, and the presence of poorly drained, undevelopable areas. These wet "swampy" areas may be dedicated as an Environmental Reserve or an Environmental Reserve Easement (section 664 of the Act; refer to Appendix A, Section K.).

A number of provisions of the *Subdivision and Development Regulation, Municipal Government Act* support requests by a subdivision authority for information on private sewage disposal systems and the suitability of the site for these systems (refer to section 4(4)(g), section 4(5)(c)(e), and section 7(a)(b)(f)(g) of the Regulation; Appendix B). For subdivisions that will use private sewage disposal systems, section 7(g) says that a subdivision authority must consider whether the proposed subdivision boundaries, lot sizes and building sites comply with the requirements of the *Plumbing Code Regulation* (Alta. Reg. 211/92).

With respect to lot size, section 8.3.3 of the *Plumbing Code Regulation* states that "Private Sewage Treatment and Disposal Systems other than Sewage Holding Tanks, shall not be installed on individual lots within, a multi lot development unless each lot contains a minimum area of 1800 m^2." This area is equivalent to 0.18 hectares, 19,376 $ft.^2$ or 0.44 acres. Where sewage holding tanks are used, this section indicates that the lot size may be less than 1800 m^2. With regard to the foregoing, it should be noted that 1800 m^2 is the minimum size of a lot with a private sewage disposal system other than a sewage holding tank. Therefore; a lot with a private sewage disposal system may be larger and still comply with the *Plumbing Code Regulation* and the *Subdivision and Development Regulation*.

The *Land Use Policies* (Appendix C) established by the Lieutenant Governor in Council pursuant to Section 622 of the *Municipal Government Act* (Appendix A, Section F.) contains a number of goals and policies relevant to these guidelines. In this regard refer in particular to section 2.0 The Planning Process, policy 3.; section 3.0 Planning Co-operation, policies 1., 2. and 3.; section 4.0 Land Use Patterns, policies 2. and 6.; section 5.0 The Natural Environment; section 6.3 Resource Conservation – Water Resources; and Appendix 1.

These guidelines are consistent with the purpose of the *Environmental Protection and Enhancement Act*, particularly with subsections 2(a)(b)(c) and (f).

> 2 The purpose of this Act is to support and promote the protection, enhancement and wise use of the environment while recognising the following:
>
> (a) the protection of the environment is essential to the integrity of ecosystems and human health and to the well-being of society;
>
> (b) the need for Alberta's economic growth and prosperity in an environmentally responsible manner and the need to integrate environmental protection and economic decisions in the earliest stages of planning;
>
> (c) the principle of sustainable development, which ensures that the use of resources and the environment today does not impair prospects for their use by future generations;
>
> (f) the shared responsibility of all Alberta citizens for ensuring the protection, enhancement and wise use of the environment through individual actions;

iv. Who Should Use these Guidelines and Under What Circumstances?

Subdivision authorities and a developer's soils consultants will likely be the major users of these Guidelines. Individual lot owners may also find them informative.

As a component of its environmental review of a residential subdivision application, a subdivision authority should consider the use of these Guidelines if:

- the subdivision will not be connected to a municipal wastewater system: and
- the subdivision will likely result in the construction of one or more new private sewage disposal systems: or
- whenever the Titled Area includes poorly drained, undevelopable areas that may potentially be set aside as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

Ideally, a developer's planning and soils consultants will use these guidelines prior to submitting the subdivision application and tentative plan to the subdivision authority. On the other hand, a subdivision authority may request that a developer hire a soils consultant to evaluate a site after it has received the subdivision application.

B. *Environmental Perspectives on Proposed Residential Subdivisions that will not be connected to a Municipal Wastewater System*

i. Introduction

It is usually unfeasible to connect a proposed rural residential subdivision to a municipal wastewater system that services a nearby urban centre. Where this connection cannot be made, there are two distinct alternatives for disposing of the wastewater generated by the subdivision's residences: use of a subdivision based wastewater collection system, or use of a private sewage disposal system within each lot.

A private sewage disposal system is a privately owned system for the treatment and disposal of sewage from privately owned developments such as a restaurant or service station, single family residence or duplex. Each system is situated within the property lines of the development it serves. The system may consist of a septic tank and subsurface disposal field, a septic tank and treatment mound, a sewage holding tank whose contents are pumped out and hauled away by tanker truck to an approved place of disposal, or other approved means of disposal. Appendix F, Section L. supplies a detailed description of common types. Private sewage disposal systems are regulated pursuant to the *Plumbing Code Regulation*.

Residential sewage wastes consist of human excretion and water-carried wastes from drinking, personal washing, laundering, food processing, etc. Satisfactory disposal of these wastes is critical to the long-term success of a residential subdivision. Wastes that have been inadequately treated and disposed of may contaminate surface and/or groundwater thereby causing a health hazard or eutrophication of these waters. The importance of the satisfactory disposal of these wastes is underlined by the numerous references to it in the *Subdivision and Development Regulation* (Section A.iii.).

Several factors including the type of waste disposal system and its maintenance, site conditions, and lot size and density must all be considered carefully to ensure the long-term sustainability of the development and a healthy environment (Section A.iii.). In this regard, it is important to recognize that rural residential subdivision lot size and density is strongly influenced by location. Intense development pressure such as found in the neighbourhood of rapidly growing urban centres or in the vicinity of highly valued landscape features, for example recreational lakes, typically results in small residential lot sizes and high lot densities. Conversely, where the development pressure is low, the lots tend to be larger and the lot densities lower.

Where a proposed subdivision's lots are less than 0.40 hectares (~ 1 acre) and the lot density is high, a subdivision authority must be particularly vigilant from an environmental and public health perspective, about site conditions and the type of waste disposal system. In a small lot there is less margin for error and a greater risk that:

- site conditions will not be optimal for establishing and maintaining a private sewage disposal system;
- insufficiently treated sewage effluent from a lot's failing private sewage disposal system may contaminate surface water and groundwater on or underlying neighbouring lots – if numerous lots are facing contamination problems, the local municipality may be forced to become responsible for the entire subdivision's waste disposal system; or
- there will not be sufficient space and/or suitable site conditions for the construction of a second disposal field should the first one fail.

Where the lots are small and it is unfeasible to connect the subdivision to a municipal wastewater system, the subdivision authority may wish to consider among other approved means of disposal, a subdivision based wastewater collection system, or the use of sewage holding tanks that are a component of a municipally operated pumping/hauling sewage collection system. To assist with the first option, the September 1986 booklet entitled *Guidelines for the Design, Approval and Operation of Sewage Lagoon Systems For Small Municipal Developments* (currently under review) is available upon request from the Municipal Water and Wastewater Branch (Edmonton, 415-1860).

ii. Private Sewage Disposal Systems for Larger Lots

Where each lot in a proposed rural residential subdivision has a Suitable Development Area (Glossary) of at least 0.40 hectares (~ 1 acre), private sewage disposal systems other than sewage holding tanks are preferred. This method of sewage disposal:

- is consistent with rural self sufficiency;
- is a standard system;
- likely will remain the complete responsibility of the individual lot owner and not the municipality;
- likely has lower capital, operation and maintenance costs than alternative methods;
- likely has the most predictable costs over the long term; and

- likely is the most energy efficient.

A private sewage disposal system should be matched with the soil conditions within the Suitable Development Area and the characteristics of the household water supply. Using these criteria, proposed rural residential subdivisions can be divided into two groups.

(1) Soils within the proposed lots are moderately permeable and the household water supply Sodium Adsorption Ratio (SAR; Glossary) does not exceed 8. In this case it is recommended that a septic tank and disposal field (Appendix F, Section L.ii.) be used on each lot.

(2) Soil conditions within the proposed lots and/or the proposed household water supply characteristics are not acceptable for a septic tank and disposal field. In this case the use of a septic tank and treatment mound (Appendix F, Section L.iii.) should be considered. Sewage holding tanks (Appendix F, Section L.iv.) should not be used unless they are a component of a municipally operated pumping/hauling sewage collection system.

There are a number of problems with sewage holding tanks and hauling effluent off site by truck including:

- reduction in rural self sufficiency;
- very high operating costs which are likely unpredictable and escalating over the long term;
- considerable energy inefficiency;
- increased heavy truck traffic within the subdivision and on adjoining roads resulting in increased noise, dust, risk of accidents and road wear;
- pumping of sewage holding tank contents over the ground surface or into creeks and lakes by home owners frustrated by high hauling costs;
- discharge of sewage at unauthorized locations by haulers unwilling to take loads to a distant approved place of disposal; and
- problems with operating this system, including the great difficulty in preventing its abuse, may force the municipality to become responsible for it.

C. *Preparation of a Residential Subdivision Soils Report by a Qualified Soils Consultant*

i. Introduction

The purpose of this section is to describe in general terms the preparation of a Residential Subdivision Soils Report by a qualified soils consultant.

ii. Hiring a Qualified Soils Consultant

If these guidelines apply, it is the applicant's responsibility to select and hire a consultant qualified in the area of soils and sewage disposal to prepare a Soils Report. Consultants may be found in the Yellow Pages under Engineers Consulting, Engineers Environmental or Environmental Consultants (see either the phone book or Telus Advertising Services' website – On-line Yellow Directories & Interactive Services http://www.alberta.com/). The Environmental Services Association of Alberta also has a lengthy directory of environmental consultants (phone 1-800-661-9278 or view the association's website at http://www.esaa.org).

If a consultant is an engineer or geologist, an applicant can determine whether the consultant is a member in good standing with the Association of Professional Engineers, Geologists & Geophysicists of Alberta (APEGGA) by contacting APEGGA (Edmonton, 426-3990).

iii. The Residential Subdivision Soils Report

As discussed in detail in Section A.iii., a subdivision authority must not approve a subdivision unless the land is suitable for the intended use. Various environmental provisions within the *Subdivision and Development Regulation* support requests by a subdivision authority for information on site conditions. Of particular relevance to these guidelines and the Residential Subdivision Soils Report are provisions relating to topography, depth to water table, and suitability of soils for any proposed private sewage disposal system.

(1) Site Observations and Evaluation

In the report, the soils consultant should provide by means of text, a large scale map, tables and drawings where applicable:

- test results and an evaluation of the site's water table (The procedure is described in Section D. This involves a preliminary evaluation of the water table, a water table test hole program and mapping of high water table areas);

- test results and an evaluation of the sites' soil percolation rate (procedures for evaluating the soil percolation rate are described in Section E.);
- an evaluation of site well logs (the importance of examining well logs to assess the risk of contaminating surface water or underlying aquifers is set forth in Section F.i.); and
- the Sodium Adsorption Ratio (SAR) of the household water supply (the method and rationale for determining the SAR is presented in Section F.ii.).

(2) Suitable Development Area of Proposed Lots

Based upon the above results and observations, the soils consultant should establish in the Residential Subdivision Soils Report whether or not each proposed unserviced residential lot has a Suitable Development Area (Glossary) of at least 0.40 hectares (~ 1 acre), especially with respect to:

- the potential for long term, satisfactory on site sewage disposal and treatment including:
  - a discussion of whether unsuitable soil conditions (high water table conditions or adverse soil percolation rates) or the SAR of the household water supply might cause private sewage disposal systems to malfunction thereby contaminating surface and/or groundwater; and
  - a recommendation as to the type of private sewage disposal system that should be used on the proposed lots
- the potential for interference with site development (building foundations and an access road) due to high water table conditions.

Any lot that does not have a Suitable Development Area should be recognized and the consultant should recommend measures for remedying the problem; for example, by altering lot boundaries or reducing lot density.

(3) Setting Aside Swampy Areas

The Soils Report should identify areas within the Proposed Subdivision Area and associated Titled Area that are swampy (wetlands; permanently high water table conditions). These areas could potentially be set aside as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

(4) Quality Assurance Statement in the Report

The subdivision authority needs high quality, trustworthy information to make a good decision. A poor study may result ultimately in residential lots that are unusable due to contaminated soils and/or groundwater. To help ensure that the study is of professional quality, the consultant and any reviewers must sign and stamp (if a member of APEGGA) the work and include a Quality Assurance Statement. The statement should assure the subdivision authority that the consultant has performed the evaluation in conformance with these guidelines.

If the report does not contain a recommendation on soils and Suitable Development Areas and/or a Quality Assurance Statement, the subdivision authority should identify this as a major deficiency and not proceed with the application until this has been remedied.

(5) Submission of the Report to the Subdivision Authority

The applicant should submit copies of the Residential Subdivision Soils Report to the subdivision authority for circulation to the municipality (if applicable), and others.

D. The Soils Report and Procedures for Evaluating the Water Table

i. Introduction

The purpose of this section is to describe procedures for evaluating the water table within the site. A consultant qualified in the area of soils and sewage disposal should evaluate the water table.

ii. General Description of the Water Table

The water table is that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere (Driscoll 1986). The water table can be viewed directly by drilling an observation well into this groundwater body and waiting for the water level to stabilize. Repeated measurement of the water level in this well over a year or so will likely reveal that the water level fluctuates, perhaps by a metre or more. The water table to ground surface separation may also vary considerably over small distances as revealed by simultaneous measurement of water levels in neighbouring wells. The water table level in a well is influenced by such factors as weather, season, water levels of nearby water bodies or water courses, groundwater discharge, surficial stratigraphy and topography.

iii. High Water Table Area and Constraints to Development

A high water table area is defined as any area where the water table is within 1.8 metres (6 feet) of the ground surface during the frost free period up until the end of August; and within 2.4 metres (8 feet) of the ground surface during the remainder of the year. This definition recognizes that the water table will probably be elevated in the spring due to the infiltration of snowmelt and during the summer rainy season. High water table levels can:

- adversely affect the functioning of a sewage disposal system, which could lead to shallow groundwater and/or surface water contamination;
- render the area unsuitable for residential basement construction, interfere with the construction of roads, etc.

The Suitable Development Area as defined in the Glossary is well drained and does not include a high water table area.

iv. Preliminary Evaluation of the Water Table

The preliminary evaluation of the water table lays the groundwork for the water table test hole program. Through the interpretation of relevant report, map and air photo information, coupled with a site inspection, a great deal can be learned about the site's water table. It is at this stage that a consultant can outline on a map suspected high water table areas.

(1) Sources of Available Information

There are many sources of information that can assist in the preliminary evaluation of the water table of the site (Appendix H, Section D.). These include topographic maps, soils and surficial geology maps and reports, water well records, air photos, and historical information on existing disposal fields within the property. Of particular interest will be any soils testing reports prepared for previous subdivision applications within the site.

(2) Easily Observed Indicators of Water Table Levels

Despite the water table being hidden from view, it is possible to reliably estimate whether it is high at given location without excavating. Indicators such as topography, water courses and water bodies, and vegetation provide valuable clues and can be readily observed on stereo air photos or during a site inspection.

- Topography

  The water table is generally a subdued reflection of the topography. Therefore, elevated areas within the site such as knolls, mounds, etc. will tend to have lower water table conditions (greater water table to ground surface separation) than those associated with depressions and valley bottoms.

- Water Courses and Water Bodies

  Areas adjacent to water courses and water bodies often have high water table conditions. Search for areas which are flat, nearly level and are only slightly higher than the water surface elevation when examining topographic maps, air photos or conducting a site inspection.

- Vegetation

  Vegetation type, which is probably the most sensitive indicator, tends to reflect the interplay of various factors and the resultant long-term range of water table levels.

  Areas forested in aspen probably have low water table conditions.

  A transition from low to high water table conditions can sometimes be detected by the presence of white birch and balsam poplar.

  High water table conditions are encountered in wetlands such as bogs, fens and marshes. These areas are usually flat or very gently sloping. In bogs, black spruce, tamarack, dwarf evergreen heaths and sphagnum moss predominate. Sedges, willows, dwarf birch and tamarack are characteristic plant species of fens. Marshes are usually found in association with shoreland areas and abound in sedges, cattails, rushes and grasses.

(3) Preliminary Delineation of Suspected High Water Table Areas on the Base Map

Based upon a review of the available maps and reports, examination air photos and possibly a site inspection, major vegetation types should be outlined on the Base Map and suspected high water table areas tentatively delineated (refer to Appendix H for Base Map preparation).

v. Water Table Test Hole Program

One of the basic methods for determining water table levels is the water table test. The test consists of drilling a hole (shallow observation well) to a depth of 3.0 metres (10 feet), allowing the water level to stabilize, then measuring the distance from the ground surface to the water level.

(1) Optimal Time for Testing

The optimal time for testing is during the spring after the frost is out of the ground. At this time the water table is generally at its peak annual level.

(2) Location of Test Holes

The water table test holes can help to fine tune or calibrate the preliminary evaluation of the water table. It is suggested that water table test holes be placed both in suspected high and low water table areas, but more importantly in transitional areas between them. In addition, areas that have been difficult to interpret should have test holes.

(3) Number of Test Holes

As a general rule, 10 water table test holes should be augured when a proposed subdivision contains a number of lots covering the majority of a quarter section. In this case, the consultant should increase this number as necessary for the proper delineation of high water table areas. At the opposite extreme, if a single residential parcel is proposed, a test hole at the proposed building site and another within the proposed disposal field will likely be sufficient.

(4) Auguring the Test Hole and Keeping a Soil Log

Augur (drill) by hand or otherwise a hole to a minimum depth of 3.0 metres (10 feet). In sandy soils where contamination of groundwater is of concern, deeper test holes may be needed. As the hole is being augured record the soil texture. For example:

Table 3.1 – Example Water Table Test Hole Soil Log

0 to 4 cm -	sandy loam, dark brown
4 to 45 cm -	sand, medium to dark brown, slightly moist, fine-grained
45 to 300 cm -	silty clay, dark olive brown, slightly moist to moist, slightly plastic

During the removal of the soils one should be particularly vigilant for the presence of soil mottling in the excavated material (spotty discoloration) which indicates the uppermost point reached by the water table. Less well-drained soils have larger and more distinct mottles and mottles closer to the surface.

When frost conditions exist, collect a soil sample for grain size analysis between 90 to 119 cm (35 to 47 inches) below the ground surface (refer to Section E. - The Evaluation of Soil Percolation Rate).

(5) Preparing the Test Hole for Water Level Measurements

Immediately after auguring the hole, insert a perforated plastic pipe such that the standpipe reaches the bottom and protrudes at least 30 cm (12 inches) above the ground surface. The standpipe should be capped to prevent the entry of airborne debris. The excavated soil should be back filled around the standpipe and lightly tamped down. At the ground surface, soil should be mounded around the standpipe to prevent entry of surface water.

The location of the test hole should be brightly marked so that it can be easily relocated. In addition, the number of the hole should be clearly indicated. The hole and its standpipe should be left intact at least until after the registration of the subdivision plan at an Alberta Land Titles Office.

(6) Water Level Measurements

Allow the water level to stabilize in the hole and measure the distance from the ground surface to the water level. This stabilisation period will be a minimum of 24 hours in sandy soils and 96 hours in clayey soils. Include in the report the time allowed for stabilisation and the date of testing.

vi. Preparation of the Water Table Site Map

Based upon the preliminary evaluation supplemented by the water table test hole program, the high water table areas should be delineated on the Base Map. This map should also outline major vegetation types and show the location of all water table and percolation test holes. In addition, the stabilized water table level within each water table test hole should be included. If bedrock is encountered within 2.4 metres of the ground surface, it should be delineated on the Base Map and its lithology described.

E. The Soils Report and the Evaluation of the Soil Percolation Rate

i. Introduction

This section discusses several methods that may be utilized by a consultant qualified in the area of soils and sewage disposal for evaluating the long-term

ability of unsaturated soil to satisfactorily treat disposal field effluent. Percolation rate testing should be conducted except when frost conditions are present 45 cm (18 inches) or more below the ground surface, in which a case particle size analysis should be performed. In addition, the site's water table test hole logs and groundwater supply well logs should be reviewed and the Sodium Adsorption Ratio of the proposed water supply determined. Notwithstanding this suggested methodology, the consultant may utilize, if necessary other types of tests.

The results of the tests are to be incorporated into the report discussed in Section C.

ii. Rationale for Methodology

If a disposal field is functioning properly there is minimal risk of surface and/or groundwater contamination by partially or completely untreated effluent. If the soils underlying a disposal field are highly permeable then effluent is not retained in the biologically active zone of the soil long enough for complete treatment. As a consequence, shallow groundwater aquifers can become contaminated with nitrates (Appendix F, nitrate contamination) and bacteria. On the other hand, if the permeability of the soil is low, there is a risk that the soil will become saturated with effluent thus resulting in the elimination of aerobes (micro-organisms living in the presence of oxygen). Their absence greatly reduces the breakdown of effluent and also leads to the rapid accumulation of suspended solids in the soil pores, thus further reducing soil permeability. The end result is disposal field failure and possibly contamination of surface water.

The long-term effectiveness of the disposal field also depends on the quality of the effluent water draining from the weeping laterals. Specifically, effluent water that is high in sodium may over time reduce the permeability of soils underlying the weeping laterals. Effluent water may be high in sodium for two major reasons, firstly the household water supply has high sodium concentrations, and secondly, the water supply is being softened by a water softener.

The risk that effluent water will reduce the permeability of the soil underlying the disposal field increases with the sodium content of the effluent and the amount and type of clay minerals in the soil. All clays have an affinity for sodium but it is greatest for the expandable clay minerals. Over time, sodium becomes the dominant element associated with the clay minerals; this causes the clay minerals to absorb more water than normal for the soil. The absorption of water causes the minerals to disperse, the soil to swell, and a reduction in the larger pores that are responsible for conducting most of the water through the soil. As this process occurs, the disposal field becomes less efficient and can lead to the failure of the system.

iii. Acceptable and Non Acceptable Percolation Rates

For a percolation test hole 20 cm. (8 inches) in diameter, percolation rates between 2.0 to 23.6 minutes/cm (5 to 60 minutes/inch) are indicative of moderately permeable soils. These soils are suitable for sewage treatment providing that low water table conditions are present and the Sodium Adsorption Ratio (Section F.ii.) of the disposal field effluent water does not exceed 8. Percolation rates that are either faster (< 2.0 minutes/cm) or slower (> 23.6 minutes/cm) reveal soil permeability conditions which are not suitable for sewage treatment.

iv. Percolation Test Procedure

(1) Percolation Test Hole Location

The hole should be placed approximately 3.0 metres (10 feet) from a water table test hole. The location of the hole should be indicated on the Base Map of the subdivision (refer to Appendix H for details of mapping requirements).

(2) Auguring Test Hole

Auger (drill) by hand or otherwise, a 20 cm (8 inch) diameter hole, to a depth of 90 cm (35 inches).

(3) Test Hole Soil Log

A description of the soil texture in each hole should be submitted.

Table 3.2 – Example Percolation Test Hole Soil Log

0 to 10 cm - clay loam

10 to 70 cm - clay

70 to 90 cm - coarse sand

(4) Test Hole Preparation

Carefully scratch the bottom and sides of the hole with a sharp pointed instrument in order to provide a natural soil interface into which the water may percolate. Remove all loose material from the hole. Place approximately 2.5 cm (1 inch) of gravel in the bottom to protect against the scouring action of added water.

(5) Initial Soaking Period for Clayey and Sandy Soils

Gently pour clear water into the percolation test hole until the water level is 45 cm below the ground surface (Figure 3.1).

- Sandy Soils

  If the soil has a sandy texture and it takes less than 10 minutes for the water to seep completely away, the percolation test may proceed immediately without a minimum 4 hour soaking period. This is because swelling should be minimal in this type of soil.

- Clayey Soils

  If the soil has a clayey texture and it takes more than 10 minutes for the water to seep completely away, the 45 cm level should be maintained for at least 4 hours or preferably overnight. This procedure is to ensure that the soil is given ample opportunity to swell. Percolation rate measurements should be made 15 hours but no more than 30 hours after the beginning of the soaking period.

  Percolation tests carried out under these conditions will be comparable to those conducted during wet periods and will provide valuable information on the percolation characteristics of the soil under normal disposal field conditions.

  Regardless of the soil texture, before performing the tests remove any soil that has sloughed into the hole during the soaking period.

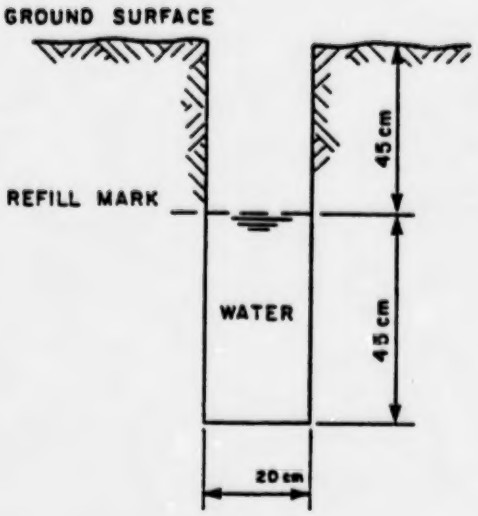
(6) Two Percolation Rate Tests

Two percolation test methods are provided; the refill and non-refill method. The non-refill method is particularly useful in clayey soils where the percolation rate is slow. The values of all measurements made on each percolation test hole should be submitted with the report. The estimated percolation rate for each hole should be shown on the Base Map.

Refill Percolation Test Method

Add water to the percolation test hole until the 45 cm REFILL MARK is reached. Measure and record the drop in water level after an interval of at least 10 minutes. From this measurement calculate the rate of drop of water in minutes per cm or minutes per inch. Repeat the above procedure until the percolation rates of three consecutive measurements are relatively the same (the three values vary by less than 10%). These last three readings yield the most reliable estimate of the percolation rate. It should be noted that water

Figure 3.1 – The Percolation Test Hole



must be added to the REFILL MARK every time a test is conducted on the percolation test hole.

Table 3.3 - Example Refill Percolation Test Results

Trial	Time increment in minutes	Increment of Drop in cm	Percolation Rate (min/cm of drop)
1	20	1.4	14.3
2	20	1.25	16
3	15	0.9	16.7
4	25	1.3	19.2
5	20	1.0	20
6	30	1.5	20

Note: Conversion of minutes/cm to minutes/inch = minutes/cm X 2.54

Non-refill Percolation Test Method

Add water to the percolation test hole until the 45 cm REFILL MARK is reached. The water level is then allowed to decline without interference. Record on at least four occasions the declining water level and the time since the beginning of the test. The water level should be observed over a minimum of 2 hours or a drop of at least 15 cm (6 inches). For each increment of drop (for example 0.6 cm) and associated time increment (for example 30 minutes) calculate the rate of drop of water in minutes per cm or minutes per inch.

Table 3.4 - Example Non-refill Percolation Test Results

Trial	Total Time minutes	Time Increment minutes	Total Drop cm	Increment of Drop in cm	Percolation Rate (min/cm of drop)
1	30	30	0.6	0.6	50.0
2	70	40	1.35	0.75	53.3
3	105	35	1.95	0.60	58.3
4	155	50	2.85	0.90	55.6

(7) Use of a Correction Factor when a Percolation Test Hole is not 20 cm in Diameter

If the diameter of the percolation test hole is other than the standard 20 cm (8 inches), a correction factor must be applied to the observed percolation rate values. If the diameter is less than the standard, then the wall area to volume will be proportionately greater than the standard, therefore the percolation rate will appear faster. Conversely, if the diameter is more than the standard, then the wall area to volume will be proportionately less than the standard, therefore the percolation rate will appear slower. Table 3.5 sets forth correction factors to be used when a percolation test hole is of non standard diameter. Multiply the percolation rate by the correction factor to obtain a rate equivalent to the standard.

Table 3.5 – Percolation Rate Correction Factors for Non Standard Diameter Percolation Test Holes

Diameter		Correction
cm	inches	Factor
10.16	4	0.50
15.24	6	0.75
25.40	10	1.25
30.48	12	1.50

v. Particle Size Analysis

(1) When Particle Size Analysis can be used as an Alternative to Percolation Testing

While a particle size analysis of a soil sample does provide some idea as to how a disposal field might operate at the test location, the percolation test is preferred. Particle size analysis should only be performed if proper percolation testing cannot be conducted due to frost conditions extending deeper than 45 cm below the ground surface and the soils in the area are non-sodic. Sodic soils are nonsaline and contain sufficient exchangeable sodium to adversely affect crop growth and soil structure. Many solonetzic soils are sodic (refer to soil survey maps and reports by the Alberta Research Council and Agriculture Canada, and irrigation suitability maps by Alberta Agriculture).

(2) Particle Size Analysis Procedure

A qualified soils consultant should supervise the drilling and collection of soil samples for particle size analyses. Samples may be acquired between 90 to 119 cm (35 to 47 inches) below the ground surface while drilling each water table test hole (refer to Section D.v., Water Table Test Hole Program, Step 4). A soils testing laboratory should analyse all soil samples using standard test procedures to determine the percentage by weight of gravel, sand, silt and clay. Possible test procedures include the Modified Hydrometer Method or a combination of sieve and hydrometer analyses.

(3) When Percolation Testing should be Conducted In Addition to Grain Size Analysis

The consultant should undertake percolation testing if the grain size analysis reveals that a soil sample is a sand or loamy sand (a minimum of 70% sand and a maximum of 16% clay), or the clay component of the soil is 35% or greater. Testing should be conducted after the frost has left the ground at the location where the sample was taken.

F. The Soils Report and the Examination of Well Logs and the Sodium Adsorption Ratio of the Household Water Supply

i. Examination of Well Logs to Assess the Risk of Contaminating Surface Water or Underlying Aquifers

The site's water table test hole logs and groundwater supply well logs provide additional information on the soil type and possibly the bedrock beneath prospective disposal fields. This information will assist in determining the risk that poorly treated effluent may contaminate either surface water or underlying aquifers (Appendix F, Nitrate Contamination). An example of a high-risk situation is where a disposal field is located in surficial sands that directly overlie a sandstone aquifer. Water Well Driller's Reports and other groundwater related information may be obtained from the Water Data Management Section (Appendix H, Section D., Item (7)).

ii. Determination of the Sodium Adsorption Ratio of the Household Water Supply

Based on experience gained in the area of irrigation water quality, it is recommended that the Sodium Adsorption Ratio (SAR) of the household water supply not exceed 8. If the SAR is greater than 8 there is the potential that the permeability of disposal field soils will be reduced causing system failure.

To evaluate the SAR, obtain a chemical analysis of the proposed household water supply from the Water Data Management Section (Appendix H, Section D., Item (7)) or groundwater consultant conducting the water supply evaluation.

If the SAR of the water supply has not already been determined, it may be calculated by using the ionic concentrations (in mg/litre) of sodium (Na), calcium (Ca) and magnesium (Mg) using the equation below:

$$SAR = \frac{Na/23}{\sqrt{(((Ca/20)+(Mg/12))/2)}}$$

Chapter 4 - Guidelines for the Evaluation of River Flooding and Erosion Hazards for Residential Subdivisions

A. Introduction

i. Revision of the April 27, 1994 Guidelines

These guidelines replace and update the April 27, 1994 *Interim Guidelines for the Subdivision of Land in Areas Adversely Affected by River Flooding and Erosion.* Numerous changes have been necessary to recognize the provisions of the new *Municipal Government Act* and associated *Subdivision and Development Regulation* that have replaced the *Planning Act* and *Subdivision Regulation.* However, it will be observed that the technical aspects of the 1994 guidelines relating to the evaluation of river flooding and erosion have not been changed substantially.

ii. Focus of these Guidelines

These guidelines help to establish whether each proposed serviced or unserviced residential lot has a Suitable Development Area (Glossary) especially with respect to the potential for river flooding and erosion to damage or destroy a lot and its development, or cause loss of life.

- A site and its development may be threatened by inundation and saturation, displacement of structures by swiftly flowing flood waters, deposition of silt and other flood debris, channel shifting, and bank erosion, saturation and collapse.

These guidelines present measures that a subdivision authority may take to avoid or mitigate flooding and erosion problems within the Proposed Subdivision Area and associated Titled Area.

- Problems may be reduced or eliminated by modifying the subdivision lot design, or under some circumstances, requiring floodproofing within individual lots.

- Undevelopable land within the Proposed Subdivision Area and associated Titled Area may be set aside as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

These guidelines also help to protect the environment.

- Development within a flood risk area may promote local bank erosion and collapse by obstructing fast flowing flood water, increasing flood water levels, and recontouring or devegetating the bank.
- Bed, shore and bank activities may destroy fish and wildlife habitat.
- Concentration of unserviced development in a flood risk area increases the chance that sewage effluent will contaminate the water course.

iii. Relationship of these Guidelines to Provincial Acts and Regulations

These guidelines are tied to environmental provisions in the *Municipal Government Act* (refer to Appendix A for complete list), its *Subdivision and Development Regulation* (see Appendix B), and the *Environmental Protection and Enhancement Act*.

According to section 654(1)(a) of the *Municipal Government Act* "A subdivision authority must not approve an application for subdivision approval unless the land that is proposed to be subdivided is, in the opinion of the subdivision authority, suitable for the purpose for which the subdivision is intended." These guidelines assist in evaluating the environmental suitability of a proposed subdivision, specifically with respect to river flooding and erosion. Land that is subject to flooding may be dedicated as an Environmental Reserve or an Environmental Reserve Easement (section 664 of the Act; refer to Appendix A, Section K.).

Many provisions within Part 1 - Subdivision Applications, of the *Subdivision and Development Regulation, Municipal Government Act* support requests by a subdivision authority for information on site conditions (Appendix B; for these guidelines refer especially to section 4(4)(e), section 4(5)(a)(d)(i), section 5(2), section 5(3)(e) and section 7(a)(d)(i)); refer also to Appendix F, Section B. - Bed, Shore and Bank of a Naturally Occurring Body of Water). This information will assist a subdivision authority to decide whether the land to be subdivided is suitable for the purpose for which the subdivision is intended (section 654(1)(a) of the *Municipal Government Act*; refer to Appendix A.I.).

The *Land Use Policies* (Appendix C) established by the Lieutenant Governor in Council pursuant to Section 622 of the *Municipal Government Act* (Appendix A, Section F.) contains a number of goals and policies relevant to these groundwater supply guidelines. In this regard refer in particular to section 3.0 Planning Co-operation, policy 7.; section 4.0 Land Use Patterns, policy 2.; section 5.0 The Natural Environment; section 6.3 Resource Conservation – Water Resources; and Appendix 1.

These guidelines are consistent with the purpose of the *Water Act*, particularly with subsections 2(a)(b)(c) and (d).

2 The purpose of this Act is to support and promote the conservation and management of water, including the wise allocation and use of water, while recognizing

(a) the need to manage and conserve water resources to sustain our environment and to ensure a healthy environment and high quality of life in the present and the future;

(b) the need for Alberta's economic growth and prosperity;

(c) the need for an integrated approach and comprehensive, flexible administration and management systems based on sound planning, regulatory actions and market forces;

(d) the shared responsibility of all residents of Alberta for the conservation and wise use of water and their role in providing advice with respect to water management planning and decision-making;

iv. Who Should Use these Guidelines and Under What Circumstances?

Subdivision authorities and a developer's river engineering consultant will likely be the major users of these Guidelines. Individual lot owners may also find them informative.

As a component of its environmental review of a residential subdivision application, a subdivision authority should consider the use of these Guidelines if:

- at least part of the Proposed Subdivision Area or associated Titled Area is within a 1 in 100 year floodplain according to a floodplain study; or
- it knows or suspects that at least part of the Proposed Subdivision Area or associated Titled Area includes flood or erosion prone areas.

Ideally, a developer's planning, surveying and river engineering consultants will use these guidelines before submitting the subdivision application and tentative plan to the subdivision authority. On the other hand, a subdivision authority may request that a developer hire a consultant to evaluate a site after it has received the subdivision application.

v. Seeking Information from the Department where a Site is Known or Suspected to be Prone to Flooding and/or Erosion

If a proposed subdivision is within an area known or suspected to be prone to flooding and/or erosion, a subdivision authority may seek further information on the site from the nearest Natural Resources Service regional office (part of Alberta Environmental Protection).

• Bow Region	Calgary office - Phone 297-6582
• Northeast Boreal Region	Edmonton office - Phone 427-5296
• Northern East Slopes	Edmonton office - Phone 427-8283
• Northwest Boreal Region	Peace River office - Phone 624-6237
• Parkland Region	Red Deer office - Phone 340-5310
•	Leduc office - Phone 986-6286
• Prairie Region	Lethbridge office - Phone 381-5995

Sometimes regional staff may confer with the River Engineering Branch (Appendix H, Section D., Item 17). This branch has at its disposal many floodplain studies, flood related maps and air photos, records of known erosion sites and hazards, and files on a variety of proposed developments situated near water features.

B. Environmental Perspectives on Proposed Residential Subdivisions that may be Adversely Affected by River Flooding and Erosion

i. Introduction to Flood Risk Information Categories and Erosion

To facilitate the environmental objective of reducing losses by flooding, it is very useful to categorize floodprone areas within the province by available flood risk information. Almost every reach of channel within a drainage network will have a floodplain next to it; however, there are usually significant variations in knowledge about these floodplains (refer to Appendix F, Section M. for a background on river flooding and erosion). Knowledge of a particular floodplain increases with:

- the availability of good air photos (especially those of flooding events)
- high water mark surveys
- nearby hydrometric stations with many years of data
- historical accounts of flooding, erosion and/or ice jamming
- detailed ground surface contour information
- surveyed river cross-sections
- river soundings
- computer floodplain modelling

As knowledge of a floodplain area grows, confidence in flood risk delineation also increases.

In Alberta, four flood risk information categories are applied to floodprone areas:

- Category 1 - Canada-Alberta Flood Damage Reduction Program;
- Category 2 - floodplain studies conducted by Alberta Environmental Protection or private consultants;
- Category 3 - substantial information but no floodplain study; and
- Category 4 - little information is available.

Flood Risk Information Categories 1 and 2 are associated with many urban centres containing floodprone areas. These areas already contain a broad range of development and continue to experience substantial development pressure. Development types commonly found in these urban floodprone areas include parks, industrial, commercial, road and residential. Because of the ample study and knowledge of these sites, confidence in the existing flood risk maps is high. In contrast, floodprone areas associated with Flood Risk Information Categories 3 and 4 tend to be rural, more numerous and collectively cover a much greater area. Generally far less is known about these areas, the exception being some agricultural areas susceptible to widespread flooding by major rivers such as the Pembina and Paddle. Agricultural and rural residential developments are frequently proposed in these floodprone areas.

While it is useful and easy to categorize floodprone areas, sites susceptible to river bank erosion cannot be similarly classified due to an absence of comprehensive studies. Any development near a water course may be adversely impacted by erosion. Often a site threatened by river erosion is also floodprone, but occasionally higher terraces and upland areas adjacent to river valleys may be affected by erosion caused slope movements (refer to Chapter 5). Typically, sites that have high lateral bank erosion rates are in the vicinity of meander scars and high water channels within the valley bottom. Erosion rates tend to be higher for streams that are braided, have a high sinuosity and/or have numerous islands. It is recommended that any site close to a water course should be examined for a potential erosion hazard, regardless of its flood risk information category (refer to Section I. – The Site Erosion Report).

ii. Category 1 Flood Risk Information - Flood Damage Reduction Program

(1) The Flood Risk Area and the Design Flood

Under the Canada-Alberta Flood Damage Reduction Program maps are being prepared delineating the flood risk area for roughly forty communities. The flood risk area is the area that would be inundated by the design flood. Where applicable, flooding caused by ice jams is considered in the determination of the design flood. In Alberta, the design flood is a 1 in 100 year flood, or one that has a one percent chance of being equalled or exceeded in any year. Within North America, the 1 in 100 year flood frequency is generally accepted to be the minimum standard for flood protection. The delineation of the flood risk area is based on extensive hydrologic and hydraulic analysis utilising various types of detailed, up-to-date information mentioned at the beginning of this section.

(2) Two-zone Flood Risk Area - Floodway and Flood Fringe

Within each community in the program a two-zone flood risk area is designated. The two zones are called the floodway and flood fringe (refer to

Figure 4.1). Floodway waters are usually associated with the channel and are the deepest, fastest, and most destructive. As a guideline, floodway water is deeper than 1 metre and/or has velocities greater than 1 metre per second. Water in the flood fringe area is shallower and moves more slowly. Where the flow is constricted, for instance near bridges, or along small tributaries only the floodway may be designated.

(3) Development within the Floodway - General

The primary objective of the Flood Damage Reduction Program is to maintain the capacity of the floodway so that the design flood can be safely passed. To ensure that land use in a designated floodway is of a non-obstructing nature, federal and provincial government policies regulate further development. No new federal or provincial government buildings vulnerable to flood damage will be constructed. Federal and provincial funding for the development of new structures will not be available and flood disaster assistance is eliminated for any buildings constructed after designation. Finally, the federal and provincial governments will encourage local municipalities to adopt land use restrictions to prohibit further development.

A general guideline of acceptable land uses in a floodway is listed below.

- Parks and Recreation:

  parks, botanical gardens, natural areas, play grounds, golf courses, open air buildings (picnic shelters, band shells, etc.), bike/ski trails and related facilities, boat/canoe launching sites and flood proofed structural facilities for recreational use with minimal obstruction to flow

- Municipal Infrastructure:

  roads, pedestrian bridges, parking facilities, structures and associated works for flood control, public utilities adjacent to and across the water course, pumping station inlets and outfalls

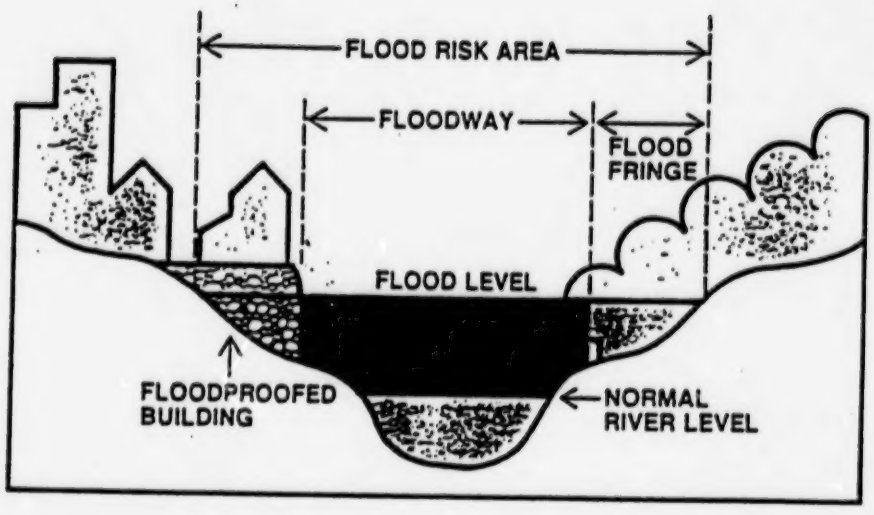
- Agriculture:

  cultivated fields, pasture, horticultural nurseries and temporary structures for agricultural use

(4) Development within the Flood Fringe - General

Federal and provincial government policies regulate further development in the flood fringe. New development may be allowed if it is adequately floodproofed to protect against the design flood (refer to Sections D. and E.

Figure 4.1 – The Floodway and Flood Fringe



for guidelines on filling, the site grading plan and special building construction). Expansion to existing development has to be floodproofed to qualify for future disaster assistance. Existing development already in place at the time of designation will continue to be eligible for government flood disaster assistance.

Filling and development within the flood fringe may cause flood water levels to increase. Flood fringe encroachment is limited by the guideline that the resulting increase in the water level should not exceed 0.3 metres.

iii. Category 2 Flood Risk Information - Floodplain Studies

Floodprone areas with Category 2 Flood Risk Information have been the subject of floodplain studies conducted by Alberta Environmental Protection or private consultants. These studies have a similar knowledge base to those in Category 1 and delineate the 1 in 100 year flood risk area and if applicable, areas inundated by major ice jam floods. However, these studies are less current than those in Category 1 and do not explicitly identify the two flood zones. The Department is upgrading and incorporating many of these studies into the Canada-Alberta Flood Damage Reduction Program.

iv. Category 3 Flood Risk Information - Substantial Available Information but no Floodplain Study

For floodprone areas with Category 3 Flood Risk Information, there is substantial available information but no floodplain study. For example, floodplains in this category may have good flood air photos, high water mark surveys, nearby hydrometric stations, historical accounts of flooding, detailed contour information, surveyed cross-sections and/or be near an area covered by an Alberta Environmental Protection Floodplain Study (Categories 1 or 2).

v. Category 4 Flood Risk Information - Little Available Information

There is little available information for a floodprone area with Category 4 Flood Risk Information. Flood elevations and the flood risk areas associated with Category 4 are difficult to define with confidence since only routine, non-flood, air photos and NTS maps (National Topographic Series) are available.

C. *Recommended Steps to be Taken by the Subdivision Authority to Avoid or Mitigate Adverse Flooding and Erosion Impacts*

i. General Approach for each Flood Risk Information Category

The previous section, Section B., presents a detailed account of Flood Risk Information Categories differentiated on the basis of available flood related information. Where there are existing floodplain studies (Flood Risk Information

Categories 1 and 2), qualified consultants or the Department can establish easily and accurately the risk of flooding for a specific location and elevation. Knowing this, the subdivision authority can make an informed choice about whether to allow development in an area inundated by the design flood (1 in 100 year flood). If the subdivision authority permits proposed lots within the design flood area, it can indicate with a high degree of confidence, flood proofing measures such as filling and special building construction that can mitigate or eliminate adverse flooding and erosion impacts.

However, as previously mentioned, the vast majority of this province's floodplain areas lie outside densely populated urban centres and do not have existing floodplain studies (floodprone areas related to Flood Risk Information Categories 3 and 4). Because many people wish to reside in rural areas near rivers, there is a significant demand for low density, residential subdivisions within these types of floodprone areas. In this situation, subdivision authorities will find that without a careful assessment, critical questions regarding the degree of flood risk and the potential for floodproofing will go unanswered.

For proposed subdivisions in floodplains, should a subdivision authority's decision making criteria vary depending upon the situation? Given the extreme seriousness of the river flooding and erosion hazard, these guidelines are based on the principle that a subdivision authority use the same stringent criteria for examining the viability of any proposed subdivision in a floodprone area, regardless of whether it is rural or urban, its lot density or Flood Risk Information Category. These criteria relate to the degree of flood risk knowledge and the severity of flooding. If for whatever reason, a proposed lot fails to meet these criteria, the subdivision authority should exclude it from the flood risk area.

The remainder of this section discusses in detail, for each Flood Risk Information Category, appropriate decision making criteria and further studies.

ii. Specific Approach - Proposed Subdivision situated within a Floodprone Area that has Category 1 Flood Risk Information

In this case, the subdivision authority knows or suspects that one or more of the proposed lots are within the floodway or flood fringe of a floodprone area with Category 1 Flood Risk Information. The subdivision authority should ask the applicant to hire a qualified consultant to accurately superimpose the floodway and flood fringe boundaries on the tentative plan. *The subdivision authority has several decisions to make in this situation.*

(1) Eliminate Proposed Lots in the Floodway

A subdivision authority should eliminate any proposed lots in the floodway that will likely result in development that will obstruct flood flows. The subdivision authority should set aside floodway areas as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental

Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

(2) Options for Avoiding or Mitigating Adverse Impacts in the Flood Fringe

A subdivision authority has two options for avoiding or mitigating adverse impacts associated with proposed lots in the flood fringe.

First, the subdivision authority may set aside these areas as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

Second, a subdivision authority may be willing to approve proposed lots in the flood fringe. To ensure that these lots are properly floodproofed against the design flood and *safeguarded from erosion*, the subdivision authority should require the applicant to submit a satisfactory Site Filling Report (Section E.) and *Site Erosion Report (Section I.)* prepared by a qualified consultant. A municipality can cover the final phase of floodproofing, special building construction (Section F.), through its development permit process.

iii. Specific Approach - Proposed Subdivision situated within a Floodprone Area that has Category 2 Flood Risk Information

In this case, upon comparison with a floodplain study, the subdivision authority knows or suspects that one or more of the proposed lots are within a floodprone area with Category 2 Flood Risk Information. The subdivision authority has two options in this situation.

(1) Eliminate all Proposed Lots in the Flood Risk Area

The subdivision authority may wish to eliminate all proposed lots within the flood risk area and set aside this area as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F). To delineate the flood risk area, the subdivision authority should ask the applicant to hire a qualified consultant to accurately superimpose the 1 in 100 year flood boundary, as shown in the floodplain study, on the tentative plan.

(2) Consider the Possibility of Development where the Flood Flow is Shallow and Slow Moving

The subdivision authority may entertain the possibility of lot development within the 1 in 100 year floodplain as delineated in an Alberta Environmental Protection Floodplain study. To determine which proposed lots have development potential, the Department (contact nearest Natural

Resources Service regional office – Section A.v.) or the applicant's qualified consultant must interpret the study. Department staff or the consultant must differentiate the 1 in 100 year floodplain within the Titled Area into areas where flood flow is deep and/or fast (similar to a floodway in a Flood Damage Reduction Program study; refer to Sections B.ii. and C.ii. for detailed discussion) versus where it is shallow and slow moving (similar to a flood fringe in a Flood Damage Reduction Program study). Based on this analysis, the various flood boundaries should be superimposed accurately on the tentative plan.

The subdivision authority should eliminate any proposed lots where flood flow is deep and/or fast. The subdivision authority may set aside these areas as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

The subdivision authority should ensure that any proposed lots in areas where the flood water is shallow and slow moving are adequately floodproofed against the design flood and *protected from erosion*. To do this, the subdivision authority should require the applicant submit a satisfactory Site Filling Report (Section E.) and *Site Erosion Report (Section I.)* prepared by a qualified consultant. A municipality can cover the final phase of floodproofing, special building construction (Section F.), through its development permit process.

iv. Specific Approach - Proposed Subdivision situated within a Floodprone Area that has Category 3 Flood Risk Information

In this case, the subdivision authority knows or suspects that one or more of the proposed lots are within a floodprone area with Category 3 Flood Risk Information. For this floodplain category there is substantial available information but no floodplain study (see Categories 1 or 2 Flood Risk Information). The subdivision authority has two major options for dealing with proposed lots in this floodplain.

(1) Identify and Eliminate all Proposed Lots in the Flood Risk Area

The subdivision authority may wish to eliminate all proposed lots within the flood risk area and set aside this area as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F). To delineate the flood risk area, the subdivision authority should request the applicant hire a qualified consultant to prepare a Flood Risk Area Boundary Assessment Report (Section G.). The applicant should accurately superimpose the flood risk area boundary, as established by the assessment, on the tentative plan.

(2) Consider the Possibility of Development where the Flood Flow is Shallow and Slow Moving

The subdivision authority may consider the possibility of lot development within areas where flood waters are shallow and slow moving (like a Category 1 flood fringe; Section B.ii.). To determine which proposed lots have development potential, the applicant should hire a qualified consultant to prepare a Full Floodplain Assessment Report (Section H.). This assessment defines the 1 in 100 year flood risk area and its elevation, differentiates between the two flood zones (areas where flood flow is deep and/or fast moving versus where it is shallow and slow moving) and identifies any erosion or ice hazard concerns. In addition, it superimposes the various flood boundaries on the tentative plan.

The subdivision authority should eliminate any proposed lots where flood flow is deep and/or fast (this is similar to a Category 1 floodway; refer to Sections B.ii. and C.ii. for detailed discussion). The subdivision authority may set aside these areas as either part of the remnant of the Titled Area, an Environmental Reserve, an Environmental Reserve Easement (Appendix A, Section K.) or a Conservation Easement (Appendix F).

The subdivision authority should ensure that any proposed lots in areas where the flood water is shallow and slow moving are adequately floodproofed against the design flood and *protected from erosion*. To do this, the subdivision authority should require the applicant submit a satisfactory Site Filling Report (Section E.) and *Site Erosion Report (Section I.)* prepared by a qualified consultant. A municipality can cover the final phase of floodproofing, special building construction (Section F.), through its development permit process.

v. Specific Approach - Proposed Subdivision situated within a Floodprone Area that has Category 4 Flood Risk Information

In this case, the subdivision authority knows or suspects that one or more of the proposed lots are within a floodprone area with Category 4 Flood Risk Information. A proposed subdivision associated with this category can be treated similarly to one that has Category 3 Flood Risk Information. However, because of a lack of information, conducting the Flood Risk Area Boundary Assessment and especially, the Full Floodplain Assessment will likely be much more difficult and expensive.

D. Flooding and Erosion Related Reports – Hiring a Qualified Consultant, Quality Assurance Statement and Submitting to an Authority

i. Introduction

These guidelines discuss the preparation by qualified consultants of a variety of reports including the Site Filling Report (Section E.), the Special Building Construction Floodproofing Report (Section F.), the Flood Risk Area Boundary Assessment Report (Section G.), the Full Flood Assessment Report (Section H.), and the Site Erosion Report (Section I.). The purpose of this section is to discuss features that are common to all of these reports.

ii. Qualified Consultant – Definition and Location

It is the applicant's responsibility to select and hire qualified consultants to prepare a report. Except where surveying is required, the consultant must be a professional engineer and a member of the Association of Professional Engineers, Geologists & Geophysicists of Alberta (APEGGA). Where a study involves surveying, an Alberta Land Surveyor may undertake this task as well as a professional engineer. Especially for the Flood Risk Area Boundary Assessment Report and the Full Flood Assessment Report, the professional engineer's area of competence should lie within the river engineering field.

The applicant can determine whether the professional engineer is a member in good standing with APEGGA by contacting its office (Edmonton, 426-3990).

Professional engineers may be found in the Yellow Pages under Engineers Consulting, Engineers Environmental or Environmental Consultants (see either the phone book or Telus Advertising Services' website – On-line Yellow Directories & Interactive Services http://www.alberta.com/). The Environmental Services Association of Alberta also has a lengthy directory of environmental consultants (phone 1-800-661-9278 or view the association's website at http://www.esaa.org).

Alberta Land Surveyors may be located in the Yellow Pages or Telus Advertising Services' website (see above) under Surveyor - Alberta Land.

iii. Quality Assurance Statement

Naturally the subdivision authority needs high quality, trustworthy information to make a good decision. To help ensure that the study is of professional quality, the consultant and any reviewers must sign and stamp the work and include a Quality Assurance Statement assuring the subdivision authority that these guidelines have been followed.

iv. Submitting the Report

The applicant should submit copies of the report to the subdivision or development authority for circulation to the municipality (if applicable), the nearest Natural Resources Service regional office (provide at least 2 copies), the River Engineering Branch (Appendix H, Section D., Item 17) and others.

E. The Site Filling Report – Floodproofing the Site

i. Introduction

A subdivision authority may make a satisfactory Site Filling Report a condition of the subdivision approval, or alternatively, a development authority may require this report as part of its development permit process (refer to Section D. for the general attributes of the report and finding qualified consultants). The subdivision or development authority should request this type of report if the Proposed Subdivision Area is within an area where flood waters are shallow and slow moving, and the development needs to be floodproofed. Floodproofing generally involves site filling followed by special building construction (Section F.). This section examines in detail site filling measures.

A good introduction to the various aspects of floodproofing may be found in a booklet prepared by the River Engineering Branch (Appendix H, Section D., Item 17), Alberta Environmental Protection. This booklet, entitled *Floodproofing Protect your home against flooding* February, 1996, is available from the Information Centre, Alberta Environmental Protection (Edmonton, 422-2079).

The applicant may require approvals to fill within the floodplain pursuant to the *Water Act*. Therefore, the applicant should contact the nearest Natural Resources Service regional office (Section A.v.) before site filling.

ii. Preparing the Site Filling Report - Site Filling and the Site Grading Plan

(1) Site Filling - Preparing the Site, Selecting Fill Soil Material, Compacting the Fill, Areal Extent and Minimum Elevation

With respect to site filling, a professional engineer should undertake the following.

- Strip top soil and other loose debris from the site and stockpile it for future use.
- Select well-graded sands and gravels for the fill material since they are the most suitable soil material to support buildings (a well-graded soil material contains a mixture of grain sizes, for instance sands, silts and clays; silts and very uniform sands are undesirable as they are difficult

to compact). The fill material should not include organic matter, debris, building rubble, etc.

- Properly compact the fill material to prevent subsidence and ensure it is impermeable.

- Fill the Proposed Subdivision Area partially or completely. Partial filling involves constructing pads for prospective buildings, roads and driveways. In either case, elevate the ground surface to the 1 in 100 year flood level or above (refer to The Site Grading Plan below, Section E.iii.(2)).

- Slope the sides of the fill in such a way as to prevent sliding and protect them against erosion.

In the Site Filling Report, the professional engineer should certify that the filling procedures described above were followed and site filling met minimum engineering requirements.

(2) The Site Grading Plan

Either an Alberta Land Surveyor or a professional engineer can survey spot elevations. The consultant must clearly demonstrate that the new ground surface meets the minimum fill elevation requirements discussed in (1) by taking enough spot elevations. The consultant should tie the survey, if possible, into a geodetic benchmark.

The consultant should place the results of the survey of the filled areas on the Base Map (refer to Appendix H for production details) thereby creating the Site Grading Plan. This map should:

- delineate and label the boundaries of the floodway and flood fringe (if area has Category 1 Flood Risk Information), or if Categories 2, 3 or 4, areas where the flows are deep and/or fast versus shallow and slow moving;
- label the 1 in 100 year flood elevation(s);
- delineate the one or more fill areas;
- show the location and elevation of each spot elevation;
- show the expected surface drainage direction within each proposed parcel by means of arrows; and

The Alberta Land Surveyor or professional engineer should stamp, sign and date the Site Grading Plan similar to the following.

Ground elevations
obtained on (date)
and certified correct

John Doe A.L.S.

F. The Special Building Construction Floodproofing Report

Through its development permit process, a development authority may require an applicant hire an Alberta Land Surveyor or professional engineer to prepare a Special Building Construction Floodproofing Report (refer to Section D. for the general attributes of the report and finding qualified consultants). The development authority should request this type of report if the Proposed Subdivision Area is within an area where flood waters are shallow and slow moving, and the development needs to be floodproofed. Floodproofing generally involves site filling (Section E.) followed by special building construction.

A good introduction to the various aspects of floodproofing may be found in a booklet prepared by the River Engineering Branch (Appendix H, Section D., Item 17), Alberta Environmental Protection. This booklet, entitled *Floodproofing Protect your home against flooding* February, 1996, is available from the Information Centre, Alberta Environmental Protection (Edmonton, 422-2079).

The builder should raise the ground floor of the building (also called the main or first floor), and the heating, mechanical and electrical installations, at least 0.5 metres above the 1 in 100 year flood elevation. Adequate elevation of the electrical installations is very important since submerged live electrical components may result in electrocution. This is a definite possibility since inundation rarely trips breakers. In general, basement development of any kind (i.e. habitable space) is not recommended in floodprone areas.

In the report, the consultant should certify that the main floor and the heating, mechanical and electrical installations meet or exceed these elevation guidelines.

G. The Flood Risk Area Boundary Assessment Report

i. Introduction

A subdivision authority may ask an applicant hire a qualified consultant to prepare a Flood Risk Area Boundary Report (refer to Section D. for the general attributes of the report and finding qualified consultants). The subdivision authority should request this type of report if the Proposed Subdivision Area appears to contain an area with Category 3 or 4 Flood Risk Information and it wishes to eliminate all proposed lots from the 1 in 100 year flood risk area. This

type of floodplain assessment is relatively simple and inexpensive compared to the Full Flood Assessment (Section H.). Especially for an area with Category 4 Flood Risk Information, where there is very little available information, flood risk area delineation should err on the side of caution.

This assessment consists of hydrology, field survey and hydraulics components. Consultants are strongly encouraged to contact the River Engineering Branch (Appendix H, Section D., Item 17) and the nearest Natural Resources Service regional office (Section A.v.) for site specific information. The River Engineering Branch has at its disposal numerous floodplain studies, flood related maps and air photos, records of known erosion sites and hazards, and files on a variety of proposed developments close to water features.

ii. Hydrology

The purpose of the hydrology component is to estimate the 1 in 100 year flood discharge near the proposed subdivision. This may be done by two different methods.

- Describing a drainage basin and comparing it with a comparable basin for which information is available.
- Describing a drainage basin, examining existing hydrometric data for this basin and performing a frequency analysis.

iii. The Field Survey (Cross-sections and/or Spot Elevations)

A qualified professional engineer consultant will select the cross-section and/or spot elevation locations. This section describes the procedure for conducting a Field Survey within suspected floodprone areas of the proposed subdivision.

(1) Surveying Cross-sections and Spot Elevations

The Field Survey involves surveying cross-sections and/or spot elevations. Conduct the survey in the following manner.

- If possible, tie both cross-sections and spot elevations into a geodetic benchmark. If the geodetic benchmark is not available, establish at least two benchmarks with assumed elevations outside the flood risk area for future reference.
- Extend each cross-section to elevated, non floodprone land on either side of the channel. Orient each cross-section perpendicular to the flow during flood conditions.

- Ensure that the vertical measurement increment along the cross-section is 0.5 metres or less except in areas too steep to walk and survey, for example a cutbank.

- Ensure each cross-section includes the bed and banks of the channel, and the water level at the time of survey. When surveying the bed, locate and record the deepest part of the channel.

(2) Placing Field Survey Results on the Base Map

Draw the location of each cross-section and/or spot elevation on the Base Map (refer to Appendix H) and show the elevation value of each surveyed point. Label the cross-sections, for example A1 - A2, B1 - B2, C1 - C2.

(3) Graphing the Cross-sections

Plot the results of the cross-section survey on graph paper with the horizontal and elevation axes labelled in metres. Show the water level on each cross-section. Label each cross-section, for example A1 - A2, corresponding to that shown on the map. Stamp, sign and date each sheet of graph paper. In addition, on each sheet, show the legal description (quarter, township, range, meridian, and if applicable, plan, lot and block) and date of survey.

(4) Plotting the Longitudinal Profile of the River Bed

The cross-section survey and spot elevations located in the deepest part of the channel provide information on the thalweg, which is the line of maximum depth along a river channel. Using the two or more thalweg data points, plot on graph paper the longitudinal profile of the river bed with the horizontal and elevation graph axes labelled in metres. On the same graph, plot the water level at each surveyed cross-section. Use these profiles to estimate the slope of the river at this location.

Stamp, sign and date the profile sheet. In addition, show on each sheet the legal description (quarter, township, range, meridian, and if applicable, plan, lot and block) and date of survey.

iv. Hydraulics

The hydraulics component of the study involves the collection and analysis of available information.

- highwater mark data
- rating curves
- water surface profiles
- flood photography
- history of ice problems (if any)

Based upon this information the 1 in 100 year flood water surface profile should be determined. The flood line of the 1 in 100 year flood and any floods of record should be superimposed on the Base Map. Areas within the flood hazard zone should be described.

v. Quality Assurance Statement in the Report

To help ensure that the study is of professional quality, the consultant and any reviewers must sign and stamp the work and include a Quality Assurance Statement. The statement should assure the subdivision authority that the consultant has followed the guidelines and accurately delineated the 1 in 100 year flood risk area boundary.

H. The Full Flood Assessment Report

i. Introduction

A subdivision authority may ask an applicant hire a professional engineer whose area of competence lies in the river engineering field to prepare a Full Flood Assessment Report (refer to Section D. for the general attributes of the report and finding qualified consultants). The subdivision authority should request this type of report if the Proposed Subdivision Area appears to contain an area with Category 3 or 4 Flood Risk Information and it is willing to consider development in areas where the 1 in 100 year flood waters are shallow and slow moving (like a flood fringe). The assessment must be sufficiently comprehensive that it will allow the accurate definition of the 1 in 100 year flood water surface within the Proposed Subdivision Area. The assessment must also differentiate the floodplain into areas where floodwaters are deep and/or fast flowing (like a floodway where flows are deeper than 1 metre and/or the flow velocity is greater than 1 metre per second) versus shallow and slow moving. Furthermore, the assessment must consider with respect to this latter area, the guideline that increases in water level resulting from encroachment should not exceed 0.3 metres.

Consultants are strongly encouraged to contact the River Engineering Branch (Appendix H, Section D., Item 17) and the nearest Natural Resources Service

regional office (Section A.v.) for site specific information. The River Engineering Branch has at its disposal numerous floodplain studies, flood related maps and air photos, records of known erosion sites and hazards, and files on a variety of proposed developments close to water features.

ii. Full Flood Assessment Report

The hydrology, field procedures and hydraulics (collection and analysis of available information) of the Full Flood Assessment are identical to those laid out in the Flood Risk Area Boundary Assessment Report (Section G.). However, the hydraulics component for this type of assessment is more comprehensive and should include for both existing and proposed conditions the following.

(1) Collection and Analysis of Available Information

The hydraulics component of the study involves the collection and analysis of available information (this part also a requirement for Flood Risk Area Boundary Assessment Report, Section G.iv.).

- highwater mark data
- rating curves
- water surface profiles
- flood photography
- history of ice problems (if any)

(2) Computer Model Calibration Using Available Hydraulics Information

The computer model should be calibrated using the available hydraulics information. The following information should be detailed in the report.

- program source and description
- calibration procedure/methodology
- discussion of 'n' values
- sensitivity of starting elevation
- modelling of bridge/culvert crossings

(3) Water Surface Profiles Based on Computer Modelling

Based on the computer modelling, show calculated water surface profiles, and profiles of the 1 in 10, 1 in 50 and 1 in 100 year floods.

(4) Mapping

Using the water surface profiles, superimpose on the Base Map (refer to Appendix H) flood lines associated with the 1 in 10, 1 in 50 and 1 in 100 year floods and any floods of record. Where applicable, differentiate the floodplain into areas where floodwaters are deep and/or fast flowing (like a floodway) versus shallow and slow moving (like a flood fringe; refer to Section B.ii. for a general discussion on the Two-zone Flood Risk Area).

(5) Supporting Tables, Figures, Maps and Appendices

The following tables, figures, maps and appendices should be included in the report.

TABLES

- Historic Floods
- Flood Frequency Distribution
- High Water Mark Data
- Calibration Results
- Computed Water Levels for
  - 1 in 10 Year Flood
  - 1 in 50 Year Flood
  - 1 in 100 Year Flood

FIGURES

- Study Area/Location Plan
- Manning's 'n' versus Discharge
- Profiles for known Floods
- Calibration Profiles
- Profiles for 1 in 10, 1 in 50 and 1 in 100 Year Floods

MAPS

- Flood Frequency Map(s)
  - cross-section locations and numbers
  - flood lines for 1 in 10, 1 in 50 and 1 in 100 year floods
  - limits of area inundated for flood of record
  - ice hazard map

APPENDICES

- Hydrology Report
- Model Documentation
  - input data
  - printouts for model calibration and production runs

iii. Quality Assurance Statement

To help ensure that the study is of professional quality, the consultant and any reviewers must sign and stamp the work and include a Quality Assurance Statement. The statement should assure the subdivision authority that the consultant has followed the guidelines, accurately determined the 1 in 100 year flood water surface elevation, and correctly delineated the 1 in 100 year flood risk area boundary, and areas where flood flows are shallow and slow moving.

I. The Site Erosion Report

A subdivision authority should make a satisfactory Site Erosion Report a condition of the subdivision approval whenever a site is floodprone. The report should be prepared by a professional engineer (refer to Section D. for the general attributes of the report and finding qualified consultants). If the site is on a non floodprone terrace or in an upland area adjacent to a valley bank then *Chapter 5 – Guidelines for the Evaluation of Hazards to Residential Subdivisions from Valley Slopes* should be used.

Consultants are strongly encouraged to contact the River Engineering Branch (Appendix H, Section D., Item 17) and the nearest Natural Resources Service regional office (Section A.v.) for site specific information. The River Engineering Branch has at its disposal records of known erosion sites and hazards, and files on a variety of proposed developments close to water features.

Air photos are an important source of information on the local erosion hazard. A site inspection can confirm impressions derived from examining these photos. Estimates of erosion rates may be obtained by comparing air photos taken over a number of years.

For a proposed subdivision, the erosion hazard can be avoided or mitigated by establishing a buffer between the lots and the erosion site and/or instituting some form of bank erosion protection. The consultant should recommend a buffer width and/or bank protection works that would protect the proposed lots and associated development over the long term.

Chapter 5 – Guidelines for the Evaluation of Hazards to Residential Subdivisions from Valley Slopes

A. Introduction

i. Revision of the April 27, 1994 Guidelines

These guidelines replace and update the April 27, 1994 *Interim Guidelines for the Subdivision of Land Adjacent to Steep Valley Banks*. The Standards and Guidelines Branch has made many revisions to the 1994 guidelines to recognize the provisions of the new Municipal Government Act and associated Subdivision and Development Regulation that have replaced the Planning Act and Subdivision Regulation. The geotechnical assessment has also been modified.

ii. Focus of these Guidelines

These guidelines for the evaluation of hazards from slope movements focus on proposed residential subdivisions near or on valley slopes within the Interior Plains of Alberta. Damaging slope movements may result from natural processes, or may be triggered by development or some combination of the two (refer to Appendix F, Section O. on causes of slope movements). Slope movements in Alberta associated with valley slopes have resulted in the loss of large amounts of farmland, destruction of buildings and infrastructure.

To prevent the destruction of residences, a subdivision authority may take measures to avoid or mitigate a slope movement hazard within the Proposed Subdivision Area and associated Titled Area. The subdivision authority may:

- modify the subdivision lot design by setting lots back from areas that may be susceptible to slope movements; and
- set aside undevelopable land as either Environmental Reserve, Environmental Reserve Easement, Conservation Easement (Appendix F) or a Titled Area remnant.

These guidelines also help to protect the environment. Owners of lots near or on valley slopes may:

- cause slope erosion and/or movement by mismanaging household water and by cuts, fills or vegetation clearing;
- destroy wildlife habitat or interfere with existing wildlife corridors;
- reduce the local visual quality of the valley;
- increase the amount of sediment in the nearby water course (turbidity); or
- contaminate the nearby water course with sewage effluent.

iii. Relationship of these Guidelines to Provincial Acts and Regulations

These guidelines are tied to environmental provisions in the *Municipal Government Act* (refer to Appendix A for complete list), its *Subdivision and Development Regulation* (see Appendix B), and the *Environmental Protection and Enhancement Act*.

According to section 654(1)(a) of the *Municipal Government Act* "A subdivision authority must not approve an application for subdivision approval unless the land that is proposed to be subdivided is, in the opinion of the subdivision authority, suitable for the purpose for which the subdivision is intended." These guidelines assist in evaluating the environmental suitability of a proposed subdivision, specifically with respect to valley related slope movement hazards. Land that is threatened by slope movements may be dedicated as an Environmental Reserve or an Environmental Reserve Easement (Environmental Reserve; section 664).

Many provisions within Part 1 - Subdivision Applications, of the *Subdivision and Development Regulation*, *Municipal Government Act* support requests by a subdivision authority for information on site conditions (Appendix B; for these guidelines refer especially to section 4(4)(e), section 4(5)(a)(c)(f)(i), and section 7(a)(b)(d)(i)). This information will assist a subdivision authority to decide whether the land to be subdivided is suitable for the purpose for which the subdivision is intended (section 654(1)(a) of the *Municipal Government Act*; refer to Appendix A.I.).

These guidelines are consistent with the purpose of the *Environmental Protection and Enhancement Act*, particularly with subsections 2(b) and (c).

"2 The purpose of this Act is to support and promote the protection, enhancement and wise use of the environment while recognising the following:

(b) the need for Alberta's economic growth and prosperity in an environmentally responsible manner and the need to integrate environmental protection and economic decisions in the earliest stages of planning;

(c) the principle of sustainable development, which ensures that the use of resources and the environment today does not impair prospects for their use by future generations;"

Land that is threatened by slope movements may also be registered as a conservation easement. All the legislative tools are now in place for the creation of conservation easements in Alberta. On September 1, 1996, Bill 39, *the Environmental Protection and Enhancement Amendment Act, 1996*, was proclaimed. The Act includes enabling provisions that allow landowners to create conservation easements. Furthermore, the *Conservation Easement Registration Regulation (A/R 215/96)* provides for registration of conservation easements. A conservation easement is a legal agreement made between a landowner and a second party, such as a qualified conservation group, local municipality or provincial government agency. The agreement contains conditions that will ensure the easement will be used for conservation purposes. The agreement is registered against the land title and applies to future landowners.

iv. Who Should Use these Guidelines and Under What Circumstances?

Subdivision authority planners and developers' consultants should use these Guidelines. Individual lot owners may also find them informative. The guidelines should be used when any part of the Proposed Subdivision Area is situated:

- in the upland area lying outside the valley but near the valley crest (refer to Section B.iv. for a definition of what constitutes near);
- on a valley side including sloping land and any higher terraces or landslide blocks; and
- on a lower terrace or floodplain near the valley side (refer to Section B.iv.).

If these guidelines apply, a subdivision authority planner may request that the developer provide a geotechnical assessment. Ideally, a developer's planning, surveying and geotechnical consultants will use these guidelines before submitting the subdivision application and tentative plan to the subdivision authority.

A subdivision authority can also use these guidelines if it finds that there is considerable development pressure at many locations near or within a river valley in its jurisdiction. In this case, the subdivision authority may find it expedient to employ a geotechnical consultant to conduct a regional geotechnical study. This study would establish either regional caution zones, or more specific setbacks from the crests and toes of valley slopes throughout the study area.

B. *Procedure for Determining whether a Geotechnical Study should be Conducted for a Proposed Subdivision near or Within a Valley*

i. Introduction

If a Proposed Subdivision Area is near or within a valley, when should a subdivision authority request a geotechnical study? It is recommended that a geotechnical study (Section C.) be conducted whenever a Proposed Subdivision Area is in the Slope Movement Caution Zone (refer to Subsections v. and vi. of this section). This zone always includes the valley side; therefore, any Proposed Subdivision Area that is completely within, overlaps onto, or abuts the valley side should have a geotechnical study.

This section examines in detail the more complex situation where a Proposed Subdivision Area is near the crest or toe of a valley side. It attempts to resolve the question of whether the Proposed Subdivision Area is near enough to the valley side that it is in the Slope Movement Caution Zone, and thus should have a geotechnical study to establish lot boundary setbacks. Two procedures are presented. The first procedure assists a planner or development officer to decide whether the Proposed Subdivision Area is near enough to a valley side to proceed further with the Guidelines. It is based on knowing only the height of the valley slope. It does not delineate the Slope Movement Caution Zone or a lot boundary setback. If the first procedure indicates the Proposed Subdivision Area is close enough to the valley side to be of concern, then the second procedure should be employed. It would be carried out by an Alberta Land Surveyor and would result in the delineation of the Slope Movement Caution Zone bordering the valley side. This procedure does not result in a lot boundary setback. If the Proposed Subdivision Area overlaps into this zone a geotechnical assessment is advisable. This assessment would contain a recommended lot boundary setback.

ii. Definition of Valley Features

In order to delineate the Slope Movement Caution Zone, it is necessary to define a number of valley features and a few simple valley measurements, slope angle and slope height.

Valleys are sometimes referred to as coulees, canyons, draws, gullies and ravines depending upon their size, shape, evolution and locally preferred name. Valleys are almost always found in association with and formed by water courses and their channels (rills, brooks, creeks, streams, rivers, waterways, etc.). In some cases water bodies may be situated on a valley floor. They are formed by the natural or artificial obstruction of stream flow. A portion of the valley floor may be floodprone and/or erosion prone. The floodprone area is referred to as a floodplain.

The valley may contain one or more bench (or platform) like features at different elevations that are relatively flat, horizontal or gently inclined (Figure 5.1). These features may be:

- active floodplains;
- terraces which are abandoned floodplain remnants; or
- large blocks that have moved downslope in landslides.

The crest of a valley is the dividing line between valley and its uplands (Figure 5.2). Specifically, the crest of a valley refers to the transition line between the valley side where grades exceed 12.3% (7°) and the adjacent upland area where slopes are less than 12.3%.

The valley side at a particular location may contain several terraces at different elevations. Of this set of terraces, the terrace with the lowest elevation (least height above the water course) is the low-level terrace. Although there are exceptions, the low-level terrace is typically more extensive (breadth and length) than its higher level terrace neighbours.

The toe of a valley slope (Figure 5.2) is where the valley side either:

- enters the water course or water body if there is no extensive low-level terrace or floodplain (commonly encountered on the outer bend of a meander); or
- meets an extensive floodplain or low-level terrace lying adjacent to a water course or water body (transition line between the valley slope above the line where grades exceed 12.3% and a floodplain or terrace surface below the line where grades are less than 12.3%).

iii. Approach to Estimating Setbacks in these Guidelines

The approach taken in these Guidelines for estimating setbacks from the crest of valleys is found in the 1993 paper by J.S. De Lugt, S. Thomson and D.M. Cruden, entitled *A suggested method for estimating setbacks from the crests of slopes on the Interior Plains in Alberta* (refer also to Appendix G, Section E.). In this paper the setback guideline SG, is given by

$$SG = R + E$$

where R is the crest regression in metres, and E is the amount of net lateral river erosion in metres.

The determination of R requires knowing several values: the slope angle in degrees, α, of the valley side area in question; the height of the slope, H; the ultimate slope angle in degrees, β_u.; and the angle in degrees that the ground rises away from the crest (if it does),.γ (refer to Figure 2, De Lugt et al).

Figure 5.1 – Cross-section of a Valley

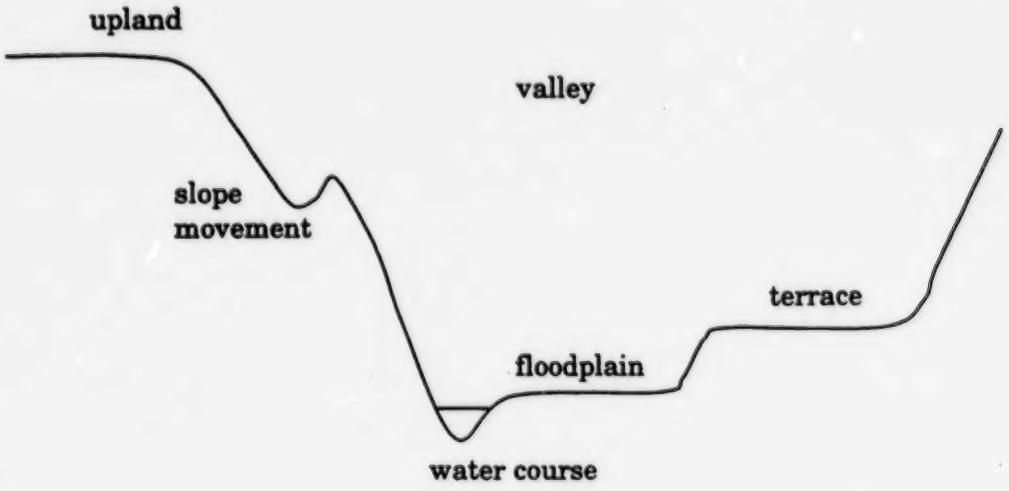
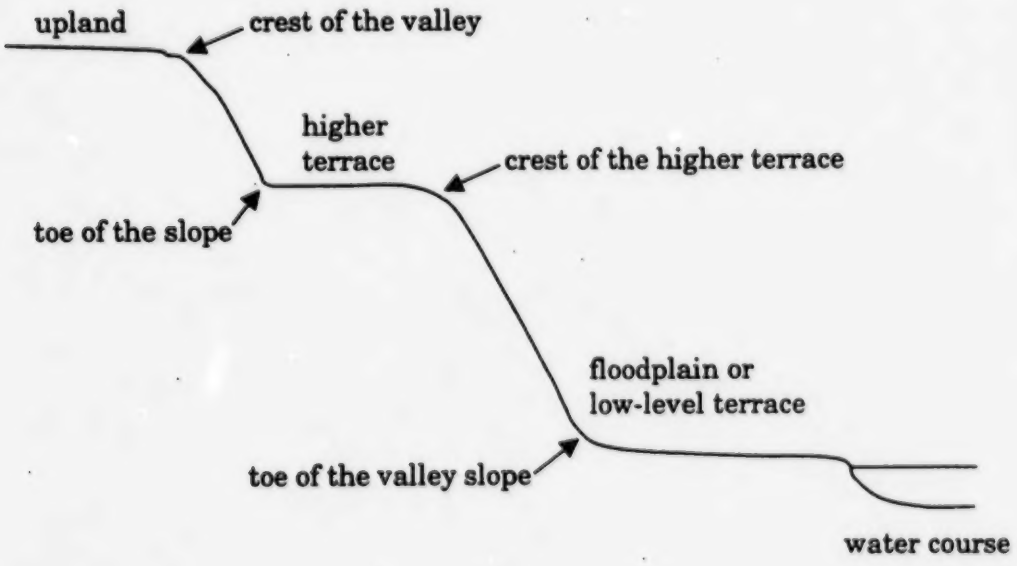


Figure 5.2 – Crests and Toes of Slopes on a Valley Side



$R = H(\cot\beta_u - \cot\alpha)(\tan\beta_u/(\tan\beta_u - \tan\gamma))$

The slope angle, α, is the inclination to the horizontal of the line from the valley crest to the closest point at the toe of the valley slope. The slope height, H, is the difference in elevation between the ends of the line. On a valley slope, the steepest slope is that with the greatest slope angle (on a topographic map it is the location where there is the least separation between valley crest and valley side toe of slope contour lines). The angle of this slope is called the steepest slope angle, α_s.

According to De Lugt et al "Abandoned slopes on the Interior Plains are those slopes not being eroded by a river at present. Mature abandoned slopes have not been eroded by a river for hundreds of years. The angles of these abandoned slopes are estimates of the ultimate slope angle β_u, the angle of ultimate stability postulated by Skempton and Hutchinson (1969, pp. 331-332)." Along river valleys on the Interior Plains, mature abandoned slopes can be recognized by the development of river terraces at the base of the slope. A reasonable estimate of β_u for a subject valley slope can be assessed by examining the angles of at least three abandoned slopes in the vicinity with similar geology, groundwater conditions and topographic form.

With respect to the regression of a mature abandoned slope guarded by a low-level terrace, the authors took the approach that it will not retrogress significantly by natural processes. However, a significant setback is still needed because it has been shown that urban development will affect slope stability adversely, especially when the groundwater regime is raised. Given this concern, a minimum setback of 20 metres from the crest of a mature abandoned slope was recommended.

iv. A Simple Procedure for determining whether the Proposed Subdivision Area is Near the Valley Side

This procedure enables a planner or development officer to decide whether the Proposed Subdivision Area is near enough to a valley side to proceed further with the Guidelines. It is based on knowing the height of the valley slope. It does not delineate the Slope Movement Caution Zone or any lot boundary setback.

Obtain a relevant topographic map of the site with a scale of 1:50,000 or larger (e.g. 1:20,000 or 1:10,000 scales are acceptable, refer to Appendix F. Section D., Sources of Information for Mapping and Site Investigations). Larger scale maps will likely have smaller contour intervals and thus provide a more accurate height value. Examine carefully the valley side area adjacent to the Proposed Subdivision Area, even if it lies outside the Titled Area. Within this valley side area find a place that has the greatest height (i.e. the most contour lines). Derive the slope height by subtracting the toe of the valley slope contour elevation from the crest of the valley slope contour elevation.

H = crest of slope contour elevation - toe of slope contour elevation

For example, H = 900 metres - 860 metres = 40 metres

Multiply this slope height value by 7.4 to determine whether the Proposed Subdivision Area is near enough to the valley side to be of concern.

For example, if H = 40 metres, then a Proposed Subdivision Area within 296 metres (40 x 7.4) of the valley side would be considered to be near.

The value of 7.4 was obtained by using values $\alpha = 23.3$, $\beta_u = 10.4$, H = 1 and $\gamma = 6$ in the equation for R given in Subsection B.iii. The α and β_u values were the mean values for the 31 landslides presented in Table 2, De Lugt et al. With respect to the angle that the ground rises away from the crest of the slope, a conservative value of $\gamma = 6$ was chosen (recall 7° is the slope of the crest of a valley). The value of 7.4 is suitably cautious when one considers that the maximum R value derived from Tables 1 and 2, De Lugt et al. is 5.5 (Home Road, Calgary; H is assumed to be 1). Although this is a conservative estimate of the setback, it also represents a balance between the risk of capturing too few and too many proposed subdivisions in this initial screening stage.

v. Determining the Slope Movement Caution Zone Boundary near the Crest of a Valley

If a Proposed Subdivision Area is in the upland and has been determined to be near a valley side using the above procedure, an Alberta Land Surveyor should ascertain whether any part lies within the local Slope Movement Caution Zone adjacent to the crest of the valley. The caution zone is not a building or lot boundary setback. Instead, it is an area in the vicinity of the Proposed Subdivision Area that could be affected by slope movements based on knowing only the steepest slope angle in degrees, α_s, the ultimate slope angle in degrees, β_u, the associated slope height, H, and the angle γ at which the ground surface in the upland rises away from the crest of the slope (measured in degrees). As in the previous procedure β_u is assumed to be 10.4.

The values for variables α_s, H, and γ should be obtained by conducting a site inspection and/or using a relevant topographic map of the site with a scale of 1:20,000 or larger (e.g. 1:10,000 or 1:5,000 scales are acceptable, refer to Appendix F. Section D., Sources of Information for Mapping and Site Investigations). Using these values, the crest regression, R can be calculated using the equation given in Subsection B.iii. The value of R defines the boundary of the Slope Movement Caution Zone adjacent to the crest of the valley. If any part of the Proposed Subdivision Area overlaps the zone, a geotechnical study should be performed (refer to Section B.vii. and Section C.).

vi. Determining the Slope Movement Caution Zone Boundary near the Toe of a Valley Slope

For a Proposed Subdivision Area on a low-level river terrace or floodplain, the width of the caution zone adjacent to the toe of a valley slope is considered to be the same as from the crest of the valley slope (for calculation refer to Subsection iii.(2) and (3), Width of the Caution Zone in Upland Area Adjacent to the Valley Crest). A proposed subdivision at this location should also be reviewed for potential flooding and erosion problems (Chapter 4).

vii. Request for a Geotechnical Assessment - at least part of the Proposed Subdivision Area is in the Slope Movement Caution Zone

If at least part of a Proposed Subdivision Area is in the Slope Movement Caution Zone, the subdivision authority should request the applicant provide a geotechnical assessment by a qualified geotechnical consultant (Section C.).

The geotechnical consultant will recommend setbacks from the valley crest or the toe of the valley slope, depending upon the location of the proposed subdivision. If a proposed residential subdivision on a higher terrace appears feasible, the geotechnical consultant will recommend a setback from both the terrace crest and adjacent toe of slope.

The geotechnical consultant will take into account not only the slope height and angle used in the caution zone delineation, but also a number of other factors including:

- the slopes of the uplands and terraces;
- presence and characteristics of lateral river erosion of the valley side toe of slope;
- presence and characteristics of terraces or a floodplain;
- presence and characteristics of active or inactive slope movements;
- slope of neighbouring mature abandoned slopes;
- characteristics of the bedrock and overburden comprising the slope;
- groundwater regime;
- past and existing anthropogenic (human caused) disturbances of the valley side (devegetation, excavation, fill, recontouring, drainage works, roads, reservoirs, water and sewer pipes, mining and tunnelling, etc.); and
- proposed anthropogenic disturbance - characteristics of the proposed subdivision including access road construction.

The setbacks recommended by a geotechnical consultant may coincide with the caution zone boundary, or more likely, will be placed somewhere inside the caution zone.

C. The Geotechnical Assessment and its Report

i. The Primary Objective of the Geotechnical Assessment

The primary objective of the geotechnical assessment is to determine the distance lot boundaries of the proposed subdivision should be:

- set back from the crest of the valley if the Proposed Subdivision Area is situated in the upland near the valley;
- set back from the toe of the valley slope if the Proposed Subdivision Area is situated on a low-level river terrace or floodplain; or
- set back from the crest of the terrace and from the adjacent toe of slope if the Proposed Subdivision Area is situated on an extensive higher level terrace.

Setbacks protect the lots and their development from the adverse effects of slope movements brought about by existing natural and anthropogenic factors, and/or the proposed development itself.

Recommendations on setbacks may augmented by recommendations dealing with lot development, for instance those pertaining to landscaping and water management (lawn watering, sewage disposal field placement, discharge of roof water, etc.). Lot development recommendations should be easily implemented and economically feasible.

It should be clearly recognized that while lot boundary setback recommendations can be implemented as a condition of subdivision approval, there are no guarantees that those relating to lot development will ever be undertaken. Therefore, it is imperative that a lot boundary setback be chosen that assumes the most detrimental lot development conditions.

ii. Hiring a Qualified Geotechnical Consultant

It is the applicant's responsibility to select and hire a qualified geotechnical consultant to conduct the geotechnical assessment. The applicant can locate professionals in the Yellow Pages under Engineers Consulting, Engineers Environmental or Environmental Consultants. The applicant can determine whether the professional is a member in good standing with the Association of Professional Engineers, Geologists & Geophysicists of Alberta (APEGGA) by contacting APEGGA (Edmonton, 426-3990).

iii. The Geotechnical Assessment and Report

The recommended method of estimating valley crest setbacks is found in the 1993 paper by J.S. De Lugt, S. Thomson and D.M. Cruden, entitled *A suggested method for estimating setbacks from the crests of slopes on the Interior Plains in Alberta* (refer to Section B.iii. for a brief description).

The Slope Movement Caution Zone described in the previous section (Section B.v. and vi.) uses this methodology to generate a relatively easy to obtain "worst case" setback line for the site in question based on knowing only the steepest slope angle in degrees, α_s, the ultimate slope angle in degrees, β_u, the associated slope height, H, and the angle γ at which the ground surface in the upland rises away from the crest of the slope (measured in degrees).

The hazard to structures near the toe of a valley slope is dissimilar to that at the crest of a valley. Slope movements at the crest of a valley may displace the foundations of nearby buildings. Structures near the toe of a valley slope may be displaced because they lie above the surface of rupture. Alternatively, the structures may lie beyond the toe of the surface of rupture but be impacted by displaced landslide material (the surface of rupture is the surface that forms, or that has formed, the lower boundary of displaced material). Impacts of small falls are reduced or contained by ditches, fences and barriers; designs to contain flows are less well understood or practiced. The angle between the crown of a landslide and its tip is called the travel angle (Cruden and Varnes, 1996). Determination of the setback from the toe of a slope should be based on a travel angle estimated by site observation and comparison, and adjusted for the slope of a terrace or floodplain using the same method described for the crest of a valley and adjacent sloping upland (Section B.iii.).

The geotechnical consultant should conduct a site inspection and evaluate of all available information including:

- air photos,
- topographic maps,
- site specific and regional geology, geotechnical and soils maps and reports, and
- the tentative subdivision plan and written description of the project.

Professional advice should be sought on the scope of the assessment. To achieve an adequate understanding of the site it may be necessary to perform a geological survey, conduct site specific drilling, install a piezometer network or slope inclinometers, observe groundwater levels, and acquire soil samples and perform laboratory tests on them.

The background, assessment methods, findings, evaluation, conclusions and recommendations regarding lot boundary setbacks and lot development should be written up in report form. As a component of the recommendations, the geotechnical consultant should delineate and label on a large scale Base Map of the site (refer to Appendix H for Base Map preparation) various features relevant to the assessment. These features include the Proposed Subdivision Area, the Slope Movement Caution Zone, recommended lot boundary setback lines, proposed access road, crest and toe of the valley slope, terraces, floodplain, slope movements, monitoring systems, test holes, etc. This is termed the Lot Boundary Setback Map.

iv. Quality Assurance Statement in the Report

The subdivision authority needs high quality, trustworthy information to make a good decision. In this hazard environment, a poor study may result ultimately in disaster. To help ensure that the study is of professional quality, the consultant and any reviewers must sign and stamp the work and include a Quality Assurance Statement. The statement should assure the subdivision authority that the consultant has followed the guidelines. Lot boundary setbacks will protect the proposed lots and their development from the adverse effects of slope movements brought about by existing natural and anthropogenic factors, and/or the proposed development itself.

v. Submitting the Geotechnical Assessment Report

The applicant should submit copies of the Geotechnical Assessment Report to the subdivision authority for circulation to the municipality (if applicable) and others.

vi. Setting Aside Undevelopable Land

Providing that the subdivision authority is satisfied with the lot boundary setback and/or setforward recommendations in the geotechnical report, and the consultant's quality assurance statement, the important question arises as to how the undevelopable land should be set aside. The subdivision authority may set aside undevelopable land as either Environmental Reserve, Environmental Reserve Easement, Conservation Easement (Appendix F) or a Titled Area remnant.

Chapter 6 – DRAFT Guidelines for the Evaluation of Lake Residential Subdivisions

A. *Introduction*

i. Development of the Lake Residential Guidelines

In mid 1994, Alberta Environmental Protection produced four environmental guidelines to assist in the review of subdivision applications. These 1994 guidelines have now been revised by the Standards and Guidelines Branch and appear as Chapters 2 to 5, in this publication. This chapter's Lake Residential Subdivision Guidelines are an important addition to the original four. The Standards and Guidelines Branch has been assisted in the development of these lake guidelines by numerous branches within Alberta Environmental Protection, Public Land Management Branch of Alberta Agriculture, Food and Rural Development and two subdivision authorities.

ii. Towards a Successful, Low Impact, Sustainable Lake Residential Subdivision

A Lake Residential Subdivision is a residential subdivision that is situated adjacent to or near a lake (a relatively large, permanent, naturally occurring body of water whose water level may in some instances be artificially controlled). Many people are highly motivated to purchase a lake lot because of a lake's recreational potential. Often, the various development and recreational activities of a lake subdivision's residents and visitors, as well other types of development near the lake and within the lake's watershed, adversely impacts the shore and lake environment, and the recreational amenity.

To minimize incremental impacts, all participants involved with the subdivision design, and post subdivision lot development and recreational activities must conscientiously over the long term take into account the environmental attributes of the site, and the lake in general.

A good subdivision plan, is an essential first step towards creating a successful, low impact, sustainable Lake Residential Subdivision. These guidelines facilitate the formation of such a plan; or in some cases where the site and/or the lake is unsuitable, discourages subdivision and development altogether. A good plan should set in motion the productive, co-operative, long-term dialogue among several parties; the prospective lot owners, the local municipality that issues development permits, those responsible for the reserve buffer (typically the local municipality), and the Crown that owns the bed and shore of the lake. This plan should also create opportunities for innovative recreational projects such as a Lake Perimeter Trail (Glossary). If concern for the natural lake environment remains

paramount, the lake should give lot owners and the general public enjoyment for many generations.

iii. Focus of these Guidelines

These guidelines focus on steps a subdivision authority may take to identify, mitigate and/or avoid environmental problems associated with a proposed residential subdivision adjacent to or near a lake. These guidelines ask a subdivision authority to consider whether:

- each proposed lot has a Suitable Development Area (Glossary) with respect to water supply, water table, sewage disposal, topography and lake specific environmental hazards;
- the shore and offshore areas adjacent to the Proposed Subdivision Area are naturally suitable for recreational development and activities, for example, walking, wading, swimming, dock construction and boating;
- the shore and offshore areas will be adversely impacted by the proposed development, for example by sewage effluent contamination and disturbance of fish and wildlife habitat;
- there will be public access to and beside the bed and shore of the lake;
- the development will adversely impact the visual quality of the lakeshore;
- the buffer strip between the proposed residential lots and the lake will be set aside as environmental reserve, an environmental reserve easement or a conservation easement (Glossary), or some combination;
- whether the width of the buffer strip is sufficient to achieve all above mentioned objectives; and
- the lake in general is suitable and/or has the carrying capacity for the proposed Lake Residential Development.

iv. Relationship of these Guidelines to Provincial Acts and Regulations

These guidelines are tied to environmental provisions in the *Municipal Government Act* (refer to Appendix A for complete list), its *Subdivision and Development Regulation* (Appendix B) and *Land Use Policies* (Appendix C), the *Environmental Protection and Enhancement Act*, the *Public Lands Act* and the *Water Act* (replaces the *Water Resources Act*).

According to section 654(1)(a) of the *Municipal Government Act* "A subdivision authority must not approve an application for subdivision approval unless the land that is proposed to be subdivided is, in the opinion of the subdivision authority,

suitable for the purpose for which the subdivision is intended". These guidelines assist in evaluating the environmental suitability of a proposed residential subdivision adjacent to a lake.

A number of provisions within Part 1 - Subdivision Applications, of the *Subdivision and Development Regulation, Municipal Government Act* support requests by a subdivision authority for information on site conditions (Appendix B; for these guidelines refer especially to section 4(4)(c)(e)(g)(h), section 4(5)(a) to (e), (i), section 5(3)(e), and section 7 of the Regulation). This information will assist a subdivision authority to determine whether or not the land to be subdivided is suitable for the purpose for which the subdivision is intended (section 654(1)(a) of the *Municipal Government Act*; refer to Appendix A.I.).

The *Land Use Policies* (Appendix C) established by the Lieutenant Governor in Council pursuant to Section 622 of the *Municipal Government Act* (Appendix A, Section F.) contains a number of goals and policies relevant to these Lake Residential Guidelines. In this regard refer in particular to section 3.0 Planning Co-operation, Policy 5.; section 4.0 Land Use Patterns, Policy 2.; section 5.0 The Natural Environment; section 6.3 Resource Conservation – Water Resources, and Appendix 1.

These guidelines are consistent with the purpose of the *Water Act*, particularly with subsections 2(a)(b)(c) and (d).

2 The purpose of this Act is to support and promote the conservation and management of water, including the wise allocation and use of water, while recognizing

(a) the need to manage and conserve water resources to sustain our environment and to ensure a healthy environment and high quality of life in the present and the future;

(b) the need for Alberta's economic growth and prosperity;

(c) the need for an integrated approach and comprehensive, flexible administration and management systems based on sound planning, regulatory actions and market forces;

(d) the shared responsibility of all residents of Alberta for the conservation and wise use of water and their role in providing advice with respect to water management planning and decision-making;

Under the *Public Lands Act* the Province of Alberta owns the bed and shore of most permanent and naturally occurring water bodies, and therefore the province takes an active interest in Lake Residential Subdivision applications. This interest is reflected in section 5(3)(e) of the *Subdivision and Development Regulation*. This section specifies that a subdivision authority must send a copy

of a complete subdivision application to the Deputy Minister responsible for administration of the *Public Lands Act* if the proposed parcel is bounded by, or contains, either wholly or partially, the bed and shore of a lake or other water body. Upon receipt of the application, the province determines whether the bed and shore has already been expressly claimed by the crown, or, if not, whether it should be claimed under section 3 of the Public Lands Act (refer to Appendix F - Glossary, Bed, Shore and Bank of a Naturally Occurring Body of Water). The province also examines fish and wildlife habitat resources adjacent to the proposed subdivision and recommends measures such as buffers to mitigate or avoid their deterioration.

v. Who Should Use these Guidelines and Under What Circumstances?

Subdivision authorities and a developer's consultants will likely be the major users of these Guidelines. Individual lot owners may also find them informative.

A subdivision authority should consider the use of these Guidelines whenever a Proposed Subdivision Area is adjacent to or near a lake. The proposed subdivision may encompass "raw" unsubdivided land, or land that has been previously subdivided.

Ideally, a developer's consultants will use these guidelines prior to submitting the subdivision application and tentative plan to the subdivision authority. Indeed, in keeping with the necessity for a co-operative, on going dialogue amongst all parties involved in a Lake Residential Subdivision, it would be most beneficial for the subdivision authority to convene a meeting before a particular subdivision design becomes "cast in stone" and is submitted as the tentative plan. The meeting would include the subdivision authority, the developer, the developer's consultants, and representatives of concerned provincial agencies responsible for public lands, water management, and fish and wildlife habitat.

Alternatively and less desirably, a subdivision authority may request that a developer hire consultants to evaluate a site using these guidelines after it has received the subdivision application and associated tentative plan.

B. Environmental Perspectives on Proposed Lake Residential Subdivisions

i. Introduction – Popularity of Lakes Leads to Environmental Problems and Conflicts between Users

Many people are powerfully drawn to lakes and they desire to live by them. The reasons for this attraction are many: natural beauty, nature study, call of the wild, peace and quiet, solitude, pioneer-like experience, family retreat, socialising, prestige, hunting and fishing, boating, water sports, etc. Inevitably, as the lakefront becomes more crowded with homes (seasonal or year round use), day use

areas, camps, etc., and the lake congested with boaters, conflicts arise amongst lake users and their values. Furthermore, the natural lake environment including fish and wildlife habitat, and water quality, suffers varying degrees of deterioration. For municipalities containing recreational lakes, existing problems "out at the lake" are often perplexing and vexing enough, without having to deal with even more development.

ii. Portrait of a Typical Lake Residential Subdivision and Development

In Alberta, what does a traditional lake subdivision and development look like? Typically, the subdivision is linear and parallels the lakeshore. Subdivided lots are separated from the lakeshore by an environmental reserve lot that is at least 6 metres in width. Development takes place not only within the confines of a subdivided lot, but also spreads out onto the adjacent reserve buffer, and the bed and shore of the lake. Development within a lot includes a residence and ancillary buildings, a driveway, a sewage disposal system, utilities and a mowed lawn. Frequently, the lot owner has cleared and manicured (mowed lawn) the reserve, and built a boathouse on it. The lot owner often significantly modifies the bed, shore and bank of the lake by constructing bank protection works (retaining walls) and a dock, clearing "weeds", and developing a sand beach.

iii. The Lake Environment and the Six Lake Zones

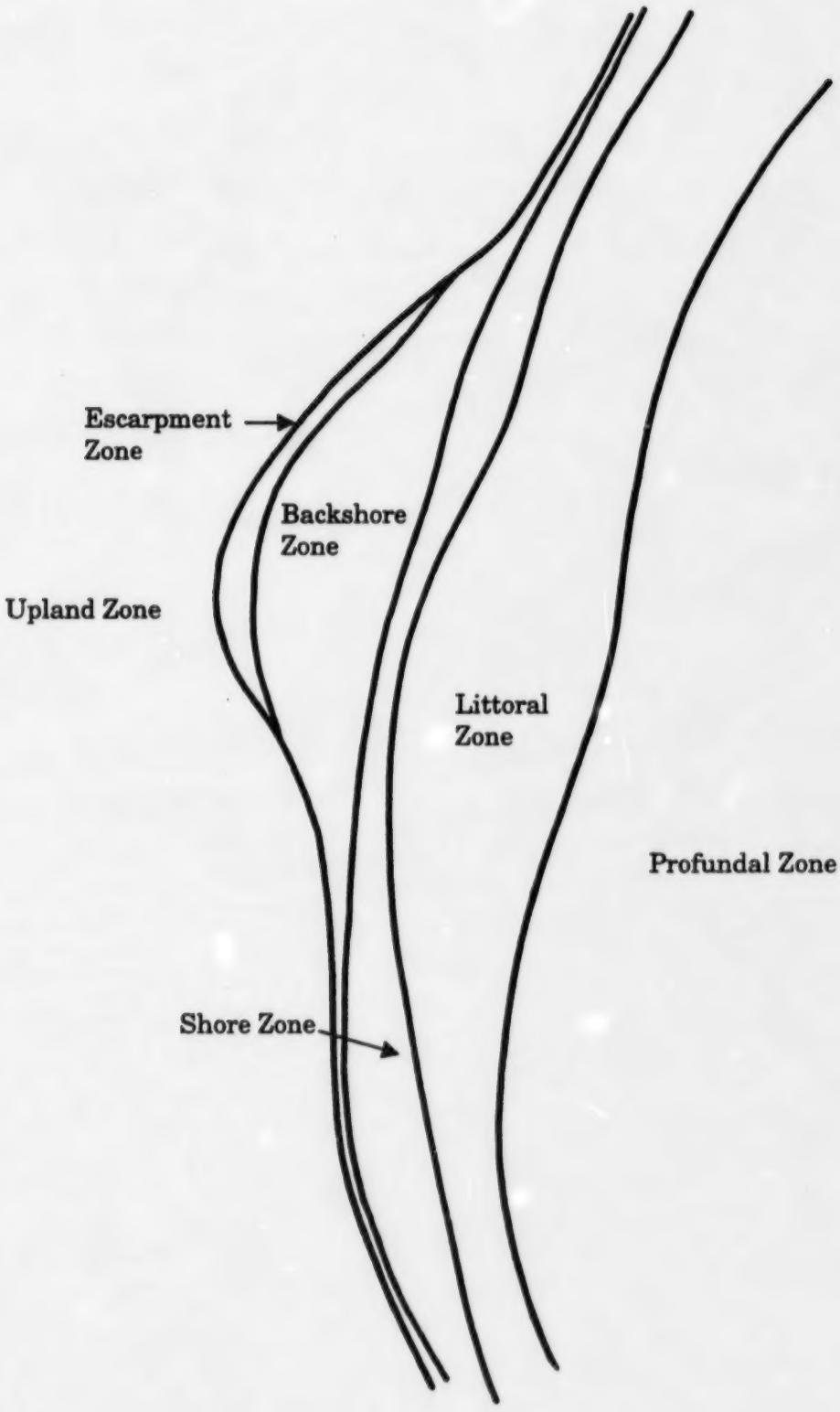
A Lake Residential Subdivision is situated in a complex environment. In order to discuss the environmental aspects of a Lake Residential Subdivision, it is important to describe six Lake Zones (Figure 6.1).

The Upland Zone is sufficiently elevated above the lake that it is not prone to flooding, wave erosion or ice thrust. This zone may lie adjacent to either the Escarpment Zone or Backshore Zone.

The Escarpment Zone is composed of a steep bank (grade greater than 15%) and a strip of land adjacent to its crest that is level or more gently sloping. On the lake side, the zone is adjacent to either the Shore Zone or Backshore Zone. On the opposite side, it is contiguous with the Upland Zone. The width of the strip adjacent to the escarpment crest may vary depending upon the bank's height and stability but should be no less than 6 metres.

The Backshore Zone consists of a shore area that is adjacent to and above the Shore Zone, and is only acted upon during major flood events or by severe storms. Depending upon the location, this zone may be extensive or very narrow. For the purposes of these guidelines, the upper limit of the Backshore Zone is equivalent to the 1 in 100 year maximum instantaneous lake level elevation plus a freeboard to allow for wind set-up and wave run-up generally in the range of 0.5 to 1.0 metres.

Figure 6.1 – Idealized Diagram Showing the Six Lake Zones



The Shore Zone is adjacent to the Littoral Zone and is that part of the lake bed which is exposed when water levels are low. The upper limit of the Shore Zone is called the legal bank. This bank is a line where land ends and the bed and shore of a water body begins. In most cases, the vegetation above the bank is markedly different from the vegetation below it due to the normal, long continued action or presence of surface water along the land at the edge of the lake. The location of the bank isn't affected by occasional periods of drought or flooding. (Appendix F – Bed, Shore and Bank of a Naturally Occurring Body of Water). This bank separates public land (crown owned) from the adjacent land (usually privately owned). Any proposed subdivision that is bounded by, or contains, either wholly or partially, the bed and shore of a lake must be referred to the Deputy Minister of the Minister responsible for administration of the Public Lands Act (Appendix F - Bed, Shore and Bank ... see above).

The Littoral Zone is that portion of the lake and its bed that is relatively well lit by the sun and supports rooted photosynthetic plants matters (Appendix F - Bed, Shore and Bank ... see above). Generally it is found around the perimeter of the lake and is situated between the Shore Zone and the Profundal Zone. Within the lake, the Littoral Zone sustains the greatest diversity of plants and animals.

The Profundal Zone is associated with the deeper, poorly lit part of a lake that does not support rooted photosynthetic plants.

iv. Environmental Objectives for Lake Residential Subdivisions

How can a subdivision authority avoid or mitigate the various environmental problems associated with a proposed Lake Residential Subdivision? The first step is to identify guiding principles or objectives that will always be kept in mind when a Lake Residential Subdivision is planned by a developer or reviewed by a subdivision authority. These environmental objectives serve as the basis for the Lake Residential Subdivision Environmental Report's site description and evaluation procedures (Section C.), and the related subdivision design options (Section D.).

These objectives recognize that environmental concerns associated with a proposed Lake Residential Subdivision are not limited to the Lake Site, but also involves the entire lake. The Lake Site means the Titled Area (Glossary) and the Proposed Subdivision Area (Glossary) within it, and those portions of the Shore and Littoral Zones that are adjacent to the Titled Area.

(1) Ensure that the Lake has the Environmental Carrying Capacity to Support New Development

The first environmental objective is to ensure that the lake has the environmental carrying capacity to support this proposed Lake Residential Subdivision. Environmental carrying capacity can be ascertained by considering factors such as fish and wildlife habitat, and fish stocks.

Regardless of the current state of development, new lake residential development should only take place on a lake that is healthy and resilient to the environmental impacts of this development.

(2) Minimize the Adverse Impacts of Development and Recreation on the Lake Site and Lake

The second environmental objective is to minimize the adverse impacts that residential and recreational development, and recreational activities associated with this proposed Lake Residential Subdivision may have on the Lake Site and the lake in general.

Within the Lake Site, development and recreational activities can:

- contaminate soils and underlying aquifers;
- destroy native vegetation and reduce and/or alter fish and wildlife habitat;
- displace animals that are sensitive to the presence of humans; and
- accelerate shore and bank erosion.

A variety of development and recreational activities linked to this proposed subdivision may contribute over time to a reduction in lake water quality.

- Sewage effluent, grey water and lawn fertilizers generated by lake residential lots within the Upland Zone may migrate to the lake thereby reducing its water quality.
  - Inadequately treated sewage effluent entering the lake may cause an health hazard.
  - Liquid wastes and fertilizers supply additional nutrients (phosphorus) to the lake. This contributes to the growth of aquatic vegetation and degrades water quality.
- Removal of natural vegetation near or adjacent to the lake reduces lake water quality because it:
  - increases soil erosion and siltation into the lake; and
  - increases the nutrient supply to the lake since plants intercept and take up phosphorus, and silty soil washed into the lake from exposed soil areas also releases phosphorus.

- Motor boat propeller action in the Littoral Zone can physically destroy aquatic vegetation and stir up lake bottom sediments thereby releasing stored nutrients such as phosphorus.

(3) Ensure that a Pristine Lake has Sufficient Natural Recreational Resources for Lake Residential Subdivision

The third environmental objective is to ensure that a pristine (undeveloped) lake has sufficient natural recreational resources to sustain Lake Residential Subdivision.

Optimally, the pristine lake has numerous developable Upland Zone areas close to the lake. Any Backshore or Escarpment Zones separating the upland from the Shore Zone can be traversed easily. The Shore Zone contains an abundance of sandy beaches and the adjacent Littoral Zone areas are suitable for swimming and wading. The lake is large, deep and its water level is stable. Its water is clear, colourless and safe for recreational activities such as swimming. The lake's upper layer is warm in the summer.

Considering these criteria, many undeveloped water bodies in Alberta are poorly suited for recreational development.

(4) Ensure that the Lake Site is Environmentally Suitable for Development

The fourth environmental objective is to ensure that the Lake Site is environmentally suitable for residential and recreational development, and recreational activities associated with this proposed Lake Residential Subdivision.

It is critical that a Lake Site contains an Upland Zone area beyond the Lake Environmental Buffer Strip (Glossary), and that at least some of this area is environmentally suitable for residential development. Every residential lot in the Upland Zone should have a Suitable Development Area (Glossary). This area is environmentally suitable for the construction and sustainable use of a residence, ancillary buildings, driveway, household water supply system and sewage disposal system. Furthermore, development and occupants within this area should face minimal risk of being adversely impacted by natural environmental hazards including flooding, wave, ice and wind erosion, ice thrust and bank instability.

Generally Lake Residential Subdivisions should be treated like other rural (country) residential subdivisions in the sense that environmental guidelines relating to water supply, water table conditions, soils and sewage disposal, and topography apply (see Chapters 2 and 3).

If it is necessary to do develop a footpath or Lakeshore Recreation Area (Glossary) within the Lake Environmental Buffer Strip portion of the Upland

Zone, at least some of this area should be suitable for these uses. Favourable Upland Areas with footpath and Lakeshore Recreation Area development potential are level to moderately sloping, and relatively dry (not wet and mucky).

An Escarpment Zone area may or may not be present within the Lake Site, and if it is, it may only partially extend across it. If it is necessary to develop a footpath within this zone, at least some of the escarpment should be suitable for footpaths. Escarpment areas with footpath development potential are moderately sloping and dry (not wet and mucky), and have relatively low relief and minimal susceptibility to toe erosion and slope movement.

The Lake Site will always contain a Backshore Zone area, however, it may be very narrow. At least some of this zone should be suitable for footpaths and Lakeshore Recreation Areas. Favourable Backshore Zone areas with footpath and Lakeshore Recreation Area development potential are dry (not wet and mucky), and have minimal susceptibility to flooding, erosion or ice thrust.

At least some of the Shore Zone and Littoral Zone areas within the Lake Site should have sufficient natural recreational resources so that recreational activities such as swimming and wading and development can occur with minimal modification of the natural environment (devegetation, regrading, filling, bank stabilisation, etc.).

- Shore Zone – Shore Zone areas that are broad, gently sloping, sandy, not prone to significant wave or ice erosion, or ice thrusting, with minimal vegetation cover or organic debris piles, have a high natural recreational potential. These areas have no constraints to beach oriented activities such as sun tanning, picnicking, or walking. An absence of significant wave and/or ice erosion facilitates the development of recreational structures such as docks.

- Littoral Zone – Generally shallow areas exposed to wave action will have a sand or gravel bottom, and little or no aquatic vegetation. These firm bottomed areas will have a good potential for swimming and wading.

Water quality within the Littoral Zone should be safe for recreational activities such as swimming.

The Lake Site's residents should have unrestricted boating access to the remainder of the lake. Boating opportunities may be limited for a couple of reasons. Firstly, the Littoral Zone within the Lake Site may be broad and shallow enough to impede near shore boat movement and docking. Secondly, the Lake Site may be on a small bay that has a mouth that is too narrow,

shallow and/or weed choked to permit boat access to the remainder of the lake.

v. Supplementary Objectives that complement the Environmental Objectives

Two supplementary objectives complement the environmental objectives listed above.

(1) Allow Public Access to the Lake

The first supplementary objective is to provide public access to and beside the bed and shore of the lake. Among other things, Section 664 of the *Municipal Government Act* states that a subdivision authority may take as environmental reserve or environmental reserve easement a strip of land, not less than 6 metres in width, abutting the bed and shore of any lake, river, stream or other body of water. One of the purposes is to provide public access to and beside the bed and shore (refer to Appendix A, Section J.ii.). The designation of an Environmental Reserve or Environmental Reserve Easement adjacent to the Shore Zone for public access purposes complements the taking of reserve for environmental purposes.

(2) Maintain Visual Quality of a Natural Undisturbed Shore Area (Scenic Shore Qualities)

The second supplementary objective is to keep the shore area in as natural a state as possible so as maintain its visual quality as viewed from the lake. It is assumed that a natural shore as seen from the lake is the most beautiful or scenic and has the highest visual quality. Development in many cases disturbs, either intentionally or unintentionally, the natural appearance of the shoreline. If this environmental objective is achieved, shore areas will be left in their natural state. This complements environmental protection objectives.

vi. Achieving Objectives by Creating and Maintaining a Lake Environmental Buffer Strip

If a Lake Residential Subdivision is environmentally feasible within the Lake Site, Environmental Objectives (2) and (4), and both Supplementary Objectives can be met, at least in part by creating and maintaining a Lake Environmental Buffer Strip between the Shore Zone and the residential lots within the Upland Zone.

(1) Basic Characteristics of the Lake Environmental Buffer Strip

To achieve these objectives, a key feature of any subdivision design is the creation of a Lake Environmental Buffer Strip of at least 30 metres between the Shore Zone and the residential lots within the Upland Zone. The buffer encompasses all Backshore and Escarpment Zone areas, and may include a

portion of the Upland Zone. As a consequence, it may be wider than 30 metres in some places. Although footpaths and possibly one or more Lakeshore Recreation Areas may be developed within the buffer, the remainder would be preserved in a natural state over the long term.

Generally, the buffer is dedicated as either environmental reserve (ER) or as an environmental reserve easement, and therefore, the municipality controls it. It is also possible that a portion of the buffer could be held as a Conservation Easement, which is a legal agreement between a landowner, and a second party, such as a qualified conservation group, local municipality or provincial government agency (Appendix F – Conservation Easement).

(2) Development of Footpaths within the Lake Environmental Buffer Strip

Footpaths within the Lake Environmental Buffer Strip of the Lake Site allow the public and especially the subdivision residents to access the Shore and Littoral Zones (Supplementary Objective (1)). There are two types of footpaths. The Trunk Footpath roughly parallels the Shore Zone and extends at least the length of the subdivision's buffer strip. Secondary Footpaths connect residential lots, Lakeshore Recreation Areas and the Shore Zone to the Trunk Footpath.

Several guiding principles should be considered during the footpath design and construction phase.

- Each footpath should be winding and narrow enough to prevent use by vehicles (likely best chance of success if they are hand cleared). It should pique interest, and take advantage of lake viewpoints and other points of interest.

- Each footpath should be confined to appropriate areas of the Upland, Escarpment and Backshore Zone portions of the buffer. These areas are where the wildlife habitat has a low significance and sensitivity to disturbance (Environmental Objective (2)), and are environmentally suitable (high recreational potential; Environmental Objective (4)). Areas with a high recreational potential for footpath development are level to moderately sloping, dry (not wet and mucky), and have minimal susceptibility to flooding, erosion, ice thrust or slope movement.

- In order to minimize the disturbance to the buffer (Environmental Objective (2)), the number and total length of Secondary Footpaths should be kept as low as possible. This principle favours footpath configurations where two or more residential lots share a Secondary Footpath.

- In order to minimize the environmental disturbance (Environmental Objective (2)) and degradation of the visual quality (Supplementary Objective (2)) of the buffer close to the Shore Zone, as well as the Shore and Littoral Zones, the number of Secondary Footpaths terminating at the Shore Zone should be kept as low as possible. This principle favours footpaths connecting to Lakeshore Recreation Areas.

- In order to provide public access to and beside the bed and shore of the lake, footpaths should make contact with the Shore Zone at several locations within the buffer (Supplementary Objective (1)). These footpaths should not be associated with those used by individual lots or those connecting to Lakeshore Recreation Areas.

- It should be the subdivision developer's responsibility to construct the footpaths.

(3) Development of Lakeshore Recreation Areas within the Lake Environmental Buffer Strip

A Lakeshore Recreation Area is entirely contained within the Lake Environmental Buffer Strip and abuts the Shore Zone. It is linked to the buffer footpath network. A recreation area provides access to the Shore and Littoral Zones (Supplementary Objective (1)), meets the subdivision residents' lake oriented recreational needs, and concentrates recreational development and activities at appropriate locations ((Environmental Objectives (2) and (4), Supplementary Objective (2)).

Several guiding principles should be considered during the Lakeshore Recreation Area design and construction phase.

- Residents of the Lake Residential Subdivision should have exclusive use of the one or more Lakeshore Recreation Areas within the Lake Site.

- Between six and eight lots should share a Lakeshore Recreation Area. The minimum value is set at six to ensure the number of Lakeshore Recreation Areas within a Lake Site is kept reasonably low. This will tend to minimize the environmental disturbance (Environmental Objective (2)) and degradation of the visual quality (Supplementary Objective (2)) of the buffer close to the Shore Zone, as well as the Shore and Littoral Zones. Eight is selected as a maximum to avoid congestion.

- The recreation area may comprise parts of the Upland and Backshore Zones. Each Lakeshore Recreation Area should be confined to where the Shore and Littoral Zone areas adjacent to the recreation area, as well as the recreation area itself, are appropriate for this use. Appropriate areas have a habitat that has a low significance and sensitivity to disturbance (Environmental Objective (2)), and are environmentally suitable (high recreational potential; Environmental Objective (4)). A recreation area with a high recreational potential is level to moderately sloping, dry (not wet and mucky), and has minimal susceptibility to flooding, erosion, ice thrust or slope movement.

- A Lakeshore Recreation Area should be accessible to subdivision residents via buffer footpaths.

- Each Lakeshore Recreation Area should be cleared and roughly semicircular in shape. Each area would have a fire pit, picnic tables, dock, etc. To ensure that the recreation area does not unduly interfere with buffer wildlife habitat protection and contamination mitigation functions (Environmental Objective (2)), and aesthetic function (Supplementary Objective (2)), the area should be of limited size. Its maximum depth (dimension perpendicular to the Shore Zone) should be 10 metres, and its maximum width (dimension measured parallel to the Shore Zone) should be 20 metres.

- It should be the subdivision developer's responsibility to construct the Lakeshore Recreation Areas.

(4) Development of a Lake Perimeter Trail

If over time, Lake Environmental Buffer Strips are consistently required by subdivision authorities, they are maintained in a near natural state by guardians of the buffer, and each contains a trunk footpath, the opportunity arises to create a Lake Perimeter Trail. The trail would consist of a narrow footpath encircling a lake whose route would be carefully chosen to take advantage of scenic viewpoints and other points of interest, while avoiding natural hazards. Gaps between neighbouring footpath segments could be bridged by various means including Conservation Easements (Appendix F) and reclaiming existing developed buffers. In time, as more trail segments are added and they merge with their neighbours, the trail would become a valuable municipal recreational and environmental resource.

(5) Issues Relating to the Long Term Care of the Lake Environmental Buffer Strip, Footpaths and Lakeshore Recreation Areas

Over the long term, the one or more parties responsible for the buffer should maintain the undeveloped portions in as natural state as possible, and

preserve any footpaths and Lakeshore Recreation Areas. There are two major strategies for accomplishing this goal.

- The buffer should be posted and signed to promote understanding of the purpose of the buffer and notify subdivision lot owners that they do not own or control this land.

- The local municipality should develop management policies for the use and monitoring of buffers, and where necessary, use regulatory mechanisms (i.e. bylaws) to enforce these policies. A balanced approach should be sought between newly created buffers and existing ones that should be reclaimed.

vii. Achieving Objectives by Residential Lot and Lake Environmental Buffer Strip Development Design

The previous section examined how environmental and supplementary objectives could be met, at least in part by creating a Lake Environmental Buffer Strip. Arrangement of the residential lots within the Upland Zone outside the buffer also plays an important part in achieving these objectives, and significantly affects how the buffer, Shore and Littoral Zones will be developed and maintained over the long term.

(1) Guiding Principles for the Design of Lake Residential Lots

Several guiding principles should be kept in mind when considering the location and configuration of the lake residential lots.

- Residential development should be set back from the lake a sufficient distance to minimize the risk of lake contamination (Environmental Objective (2)). Setbacks can be achieved by means of the buffer, intervening roads, lot configuration, etc.

- Residential lots in the Upland Zone should be confined to appropriate upland areas. These areas are where the wildlife habitat has a low significance and sensitivity to disturbance (Environmental Objective (2)), and are environmentally suitable (Environmental Objective (4)).

- Subdivision residents should be able to reach easily Shore Zone access points such as Lakeshore Recreation Areas via the footpath network. This principle favours residential designs where each lot is close to a Shore Zone access point.

- Through lot design and location, minimize the risk that individual lot owners will engage in unauthorized modifications of neighbouring buffer, Shore and Littoral Zone areas. This is especially critical in areas that are inappropriate for recreation (contains a habitat that is significant and sensitive to disturbance; Environmental Objective (2)) and/or is environmentally unsuitable for recreational development or activities (Environmental Objective (4)). This principle favours a design where the residential lots do not abut the buffer.

(2) Six Major Subdivision Design Options

For a given Lake Site and number of proposed residential lots, a planner potentially can choose one of six major designs for the lots and associated recreational development within the Lake Environmental Buffer Strip (Figure 6.2). As will be discussed later in detail, these design options vary markedly with respect to fulfilling the guiding principles set forth for buffer and residential development.

1. Continuous Linear Lot Arrangement, Lots abut the Buffer

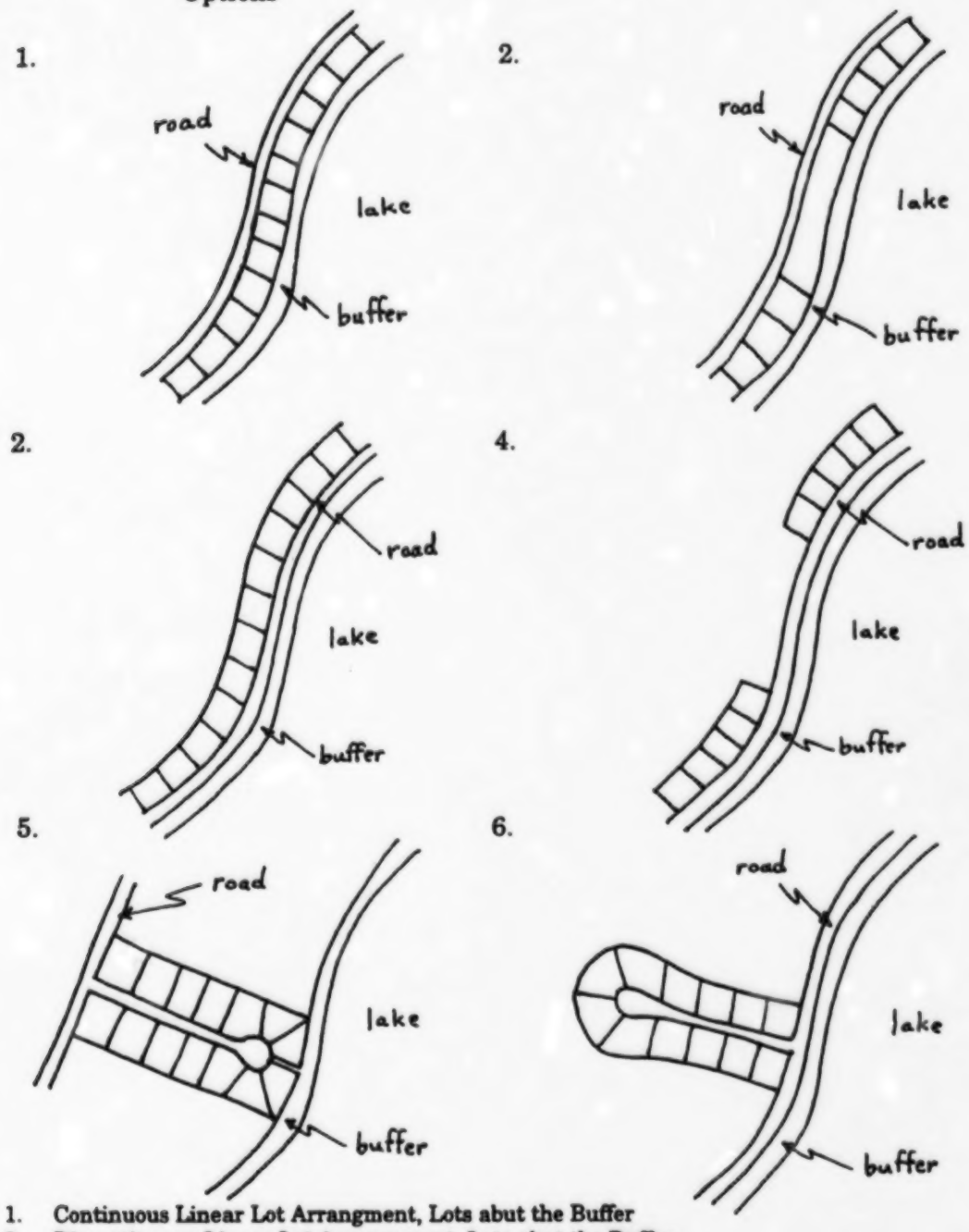
The residential lots are arranged in a traditional linear manner with road access being approximately parallel to the buffer but not touching it. Lots on the lake side of the road abut the buffer and form a continuous line (may be breaks for pedestrian walkways). There also may be lots on the opposite upland side of the road (back lots) that gain access to the buffer and Shore Zone via pedestrian walkways. Secondary Footpaths and a Trunk Footpath are developed and maintained within the buffer.

(a) The rear of each lot on the lake side of the road as well as each pedestrian walkway is connected to the Shore Zone via its own individual Secondary Footpath that traverses the buffer and associated Trunk Footpath.

(b) The rear of each lot on the lake side of the road and each pedestrian walkway is connected to a Trunk Footpath via its own Secondary Footpath. The Trunk Footpath in turn links by way of Secondary Footpaths to one or more shared Lakeshore Recreation Areas.

(c) Each pedestrian walkway is connected to a Trunk Footpath via its own Secondary Footpath. The Trunk Footpath in turn links by way of Secondary Footpaths to one or more shared Lakeshore Recreation Areas. Footpaths do not join the rear of each lake side lot.

Figure 6.2 – Idealized Diagrams Showing Six Major Subdivision Design Options



1. Continuous Linear Lot Arrangment, Lots abut the Buffer
2. Discontinuous Linear Lot Arrangement, Lots abut the Buffer
3. Continuous Linear Lot Arrangement, Lots Separated from the Buffer by a Road
4. Discontinuous Linear Lot Arrangement, Lots Separated from the Buffer by a Road
5. Residential Lots in Clusters that abut the Buffer
6. Residential Lots in Clusters, Each Cluster Separated from the Buffer by a Road

2. Discontinuous Linear Lot Arrangement, Lots abut the Buffer

   This design option is identical to 1. except that there is one or more breaks within the line of lots. Breaks are significantly wider than those associated with pedestrian walkways. Options 2.(a), 2.(b) and 2.(c) are identical to 1.(a), 1.(b) and 1.(c).

3. Continuous Linear Lot Arrangement, Lots Separated from the Buffer by a Road

   The residential lots are arranged in a traditional linear manner. They form an uninterrupted line parallel to the Shore Zone; however, they are separated from the buffer by a road. Secondary Footpaths and a Trunk Footpath are developed and maintained within the buffer.

   (a) Across the road from each residential lot is the entry point to its own Secondary Footpath. This footpath traverses the buffer and associated Trunk Footpath, and connects directly to the Shore Zone.

   (b) Across the road from the residential lots there are a number of entry points to Secondary Footpaths. Each lot may have its own entry point or several lots may share one. The Secondary Footpaths connect to a Trunk Footpath that in turn links via Secondary Footpaths with one or more shared Lakeshore Recreation Areas.

4. Discontinuous Linear Lot Arrangement, Lots Separated from the Buffer by a Road

   This design option is identical to 3. except that there is one or more breaks within the line of lots. Options 4.(a) and 4.(b) are identical to 3.(a) and 3.(b).

5. Residential Lots in Clusters that abut the Buffer

   The residential lots are concentrated in one or more clusters within the Lake Site. Lots within a cluster are arranged in a way other than the traditional linear manner where the lots approximately parallel the buffer (refer to major subdivision design options 1. to 4.). Each cluster is served by its own road. While one to four lots in a cluster abut the buffer, at least half of the cluster's lots do not. Cluster residents gain access to the buffer and Shore Zone via a pedestrian walkway developed between or beside lots abutting the buffer. Adjoining the walkway is a Secondary Footpath that connects to a Trunk Footpath. The Trunk Footpath in turn links by means of Secondary Footpaths to one or more shared Lakeshore Recreation Areas.

6. Residential Lots in Clusters, Each Cluster Separated from the Buffer by a Road

   This design option is similar to 5., except that the lots closest to the buffer abut a road instead of the buffer. Across the road from each cluster is an entry point to a Secondary Footpath that connects to a Trunk Footpath.

(3) Desirability of the Major Subdivision Design Options

Subdivision design options presented in vii.(2) are ordered from least preferred to most preferred with respect to the degree to which they could conform, for a particular Lake Site and number of proposed residential lots, to the guiding principles set forth for buffer and residential development (i.e. 1.(a) least preferred; 6. most preferred). The order also reflects the chances that a particular design, if implemented, would meet over the long term Environmental Objectives (2) and (4), and both Supplementary Objectives (i.e. 1.(a) least chance; 6. best chance).

Subdivision design options 1 and 2 most closely correspond to the status quo since the lots abut the buffer (refer to Section B.ii. for a portrait of a typical Lake Residential Subdivision). These design options carry with them the high risk that individual lot owners on the lake side of the road will modify without authorization neighbouring buffer, Shore and Littoral Zone areas. As well, since the lots are relatively close to the lake, there may be in some cases an increased risk of lake contamination. Options 1.(b), 1.(c), 2.(b) and 2.(c) are superior to options 1.(a) and 2.(a) because lakeshore recreational activities are focused on carefully selected, shared, Lakeshore Recreation Areas. Option 2 with its discontinuous linear lot arrangement is better than Option 1 since it can be adapted to site conditions within the Upland and neighbouring buffer, Shore and Littoral Zone areas.

Subdivision design options 3. and 4. differ from 1. and 2. because a road separates the residential lots from the buffer. The presence of the road reduces the risk that lots owners will modify without authorization buffer, Shore and Littoral Zone areas. As well, the road may reduce in some cases the risk of lake contamination. Options 3.(b) and 4.(b) and are superior to options 3.(a) and 4.(a) because lakeshore recreational activities are focused on carefully selected, shared, Lakeshore Recreation Areas. Option 4 with its discontinuous linear lot arrangement is better than Option 3 since it is responsive to limiting site conditions within the Upland and neighbouring buffer, Shore and Littoral Zone areas.

Subdivision design options 5. and 6. differ from the preceding options because the lots are arranged in clusters. Cluster designs, are even more adaptable than discontinuous linear lot arrangements, particularly where the Upland Zone area within the Lake Site has very limited development potential due to wildlife habitat and/or environmental suitability. Overall, this arrangement sets lots back further from the lake than linear designs, and thus poses in many cases the least risk of lake contamination. The cluster designs also focus lakeshore recreational activities on carefully selected, shared, Lakeshore Recreation Areas. Option 6. is the best cluster configuration since the road separating the cluster from the buffer reduces the risk that lots owners closest to the buffer will modify without authorization buffer, Shore and Littoral Zone areas.

viii. Achieving Objectives by Proper Siting of a Boat Launch

If a boat launch is not available locally and the site is appropriate, one could be constructed at an adjacent road allowance by the developer. The boat launch site should be situated where the fish and wildlife habitat has a low significance and sensitivity to disturbance (Environmental Objective (2)), and is environmentally suitable (Environmental Objective (4)).

C. *Preparation and Submission of a Lake Residential Subdivision Environmental Report by Qualified Environmental Consultants*

i. Introduction

This section discusses in detail the preparation and submission of the Lake Residential Subdivision Environmental Report. It describes the procedure for hiring qualified consultants, lists sources of available information, and presents a series of tasks for the consultants to perform.

ii. Hiring Qualified Environmental Consultants

It is the applicant's responsibility to select and hire consultants qualified in the area of groundwater supply, soils and sewage disposal, hydrology, and lake fish and wildlife habitat to prepare a Lake Residential Subdivision Environmental Report. Since a broad range of expertise is needed, it is envisaged that a team of consultants would be involved with site inspections, evaluation and report writing. Consultants may be found in the Yellow Pages under Engineers Consulting, Engineers Environmental or Environmental Consultants (see either the phone book or Telus Advertising Services' website – On-line Yellow Directories & Interactive Services http://www.alberta.com/). The Environmental Services Association of Alberta also has a lengthy directory of environmental consultants (phone 1-800-661-9278 or view the association's website at http://www.esaa.org).

If a consultant is an engineer or geologist, an applicant can determine whether the consultant is a member in good standing with the Association of Professional Engineers, Geologists & Geophysicists of Alberta (APEGGA) by contacting APEGGA (Edmonton, 426-3990). Similarly, for a biological consultant, an applicant can contact the Alberta Society of Professional Biologists (Edmonton, 1-800-711-5765).

iii. The Lake Residential Subdivision Environmental Report

As discussed in detail in Section A.iii., a subdivision authority must not approve a subdivision unless the land is suitable for the intended use. Various environmental provisions within the Act's *Subdivision and Development Regulation* support requests by a subdivision authority for information on site conditions. Of particular relevance to these guidelines and the Lake Residential Subdivision Environmental Report are provisions relating to topography, flooding, erosion, the bed and shore of a lake, soil characteristics, depth to water table, and suitability of soils for private sewage disposal systems.

In this report, the consultants should focus on obtaining sufficient environmental information that the environmental and supplementary objectives presented in Section B. can be achieved through subdivision design, etc. (refer to Section D.), or in some instances, not approving a subdivision.

(1) Sources of Lake Information

Besides a site inspection, there are likely many sources of information on the lake and the subject site. These sources will be referred to by number in succeeding subsections.

1. air photos (Appendix H, Section D., Items (8), (11) and (13))
2. Atlas of Alberta Lakes (Appendix H, Section D., Items (2) and (11))
3. Chapter 2 of this report – Groundwater Evaluation
4. Chapter 3 of this report – Soils and Sewage Disposal
5. fish stock (Appendix H, Section D., Item (2), or nearest regional Natural Resources (NR) office, Alberta Environmental Protection)
6. fish and wildlife habitat (Appendix H, Section D., Item (2), or nearest regional Natural Resources (NR) office, Alberta Environmental Protection)
7. hydrographic maps (bathymetry - Appendix H, Section D., Items (8) and (11)
8. lake area structure plans and lake management plans (available for

local municipality or subdivision authority)

9. lake water levels (Appendix H, Section D., Item (7), Surface Water Products)

10. reports and studies (Appendix H, Section D., Item (2))

11. soil surveys (general - Appendix H, Section D., Items (2) and (5))

12. topographic maps (Appendix H, Section D., Items (3), (6), (8) and (11))

13. water quality (Appendix H, Section D., Items (2) and (7))

(2) Evaluate the Environmental Carrying Capacity of the Lake for New Residential Development

Consistent with Environmental Objective (1), investigate whether the lake has sufficient environmental carrying capacity to support new residential development. Environmental carrying capacity can be addressed by considering fish and wildlife habitat, and fish stock factors.

For a pristine lake, describe the wildlife habitat in the Upland Zone near the lake, and the lake's Escarpment, Backshore and Shore Zones. Characterize the fish and wildlife habitat in the Littoral Zone (Sources of Lake Information: site inspection, 1., 2., 6., 10.). Using available information, portray the current state of fish stocks and pressure on these stocks by sport and/or commercial fisheries. Evaluate the sensitivity/resilience of the lake environment (fish and wildlife habitat, wildlife and fish stocks) to any recreational development.

For a lake with existing recreational development, estimate the percent of the shoreline that has been developed for recreational purposes (Sources of Lake Information: site inspection, 1., 2., 6., 8., 10.). Using this and any other relevant information, estimate the current loss of wildlife habitat in the Upland Zone near the lake, and the lake's Escarpment, Backshore and Shore Zones. Moreover, estimate the loss of fish and wildlife habitat in the lake's Littoral Zone. Using available information describe the current state of fish stocks and pressure on these stocks by sport and/or commercial fisheries, and loss of fish habitat (Sources of Lake Information: 5., 8., 10.). Evaluate the sensitivity/resilience of the lake environment (fish and wildlife habitat, and fish stocks) to any further recreational development.

(3) Evaluate the Natural Recreational Resources of a Pristine Lake for Lake Residential Subdivision

If the lake adjacent to the proposed Lake Residential Subdivision is pristine, evaluate whether the lake has sufficient natural recreational resources to

sustain this development (refer to Environmental Objective (3), Section B.iv. for evaluation criteria; Sources of Lake Information: site inspection, 1., 2., 6., 7., 8., 10., 12.).

(4) Preparation of a Lake Site Base Map

In the Lake Residential Subdivision Environmental Report, delineate and label on a Base Map (refer to Appendix H for Base Map preparation) those portions of the five lake zones within the Lake Site. The Lake Site encompasses the Titled Area and Proposed Subdivision Area within it, and those portions of the Shore and Littoral Zones that are adjacent to the Titled Area. This map is henceforth referred to as the Lake Site Base Map (Sources of Lake Information: site inspection, 1., 2., 7., 8., 10., 12.).

In addition, show or label on the Lake Site Base Map the following.

- Show on the map the Titled Area, Proposed Subdivision Area, proposed lots if they already have been identified, and the Lake Environmental Buffer Strip.
- Upland Zone – Show on the map Upland Zone areas within and outside the buffer.
- Escarpment Zone – If this zone is present, label the height and slope of the escarpment at various locations.
- Backshore Zone – Label the width of the Backshore at various locations and its uppermost elevation.
- Shore Zone - Label the width of the Shore Zone at various locations, and the difference in elevation between the current water level and the upper limit of the zone, the Legal Bank. Label the elevation of the Legal Bank.
- Littoral Zone - Depict the lake depth contours (bathymetry) within this zone.

(5) Evaluate Habitat within the Lake Site

Using the Lake Site Base Map described above, create a Fish and Wildlife Habitat Theme Map. Delineate and label on this map the distribution of vegetation for each zone. Within the Littoral Zone delineate and label the distribution of aquatic macrophytes (emergent, floating-leaved, free-floating and submergent – identify types e.g. cattails) – Sources of Lake Information: site inspection, 1., 2., 6., 8., 10., 11., 12.).

Referring to this map, describe the site's fish and wildlife habitat in the report.

In addition, for each Lake Zone, evaluate the significance and sensitivity to disturbance of the vegetation.

- Upland Zone - Evaluate the significance and sensitivity to disturbance of the vegetation as nesting and feeding habitat for wildlife (birds, moose, deer, beaver, muskrat, etc.). Disturbance will be due to residential and yard development outside the buffer, and footpath and Lakeshore Recreation Area development within the buffer.

- Escarpment Zone - Evaluate the significance and sensitivity to disturbance of the vegetation as nesting and feeding habitat for wildlife (birds, moose, deer, beaver, muskrat, etc.). Disturbance may be due to footpath development and use.

- Backshore Zone - Evaluate the significance and sensitivity to disturbance of the vegetation as nesting and feeding habitat for wildlife (waterfowl, birds of prey, wading birds, moose, deer, beaver, muskrat, etc.). Disturbance may be due to footpath and Lakeshore Recreation Area development and use.

- Shore Zone - Evaluate the significance and sensitivity to disturbance of the vegetation as nesting and feeding habitat for wildlife (waterfowl, birds of prey, wading birds, moose, deer, beaver, muskrat, etc.). Disturbance may be due to recreational activities, weed removal, sand beach development, bank protection works or dock development.

- Littoral Zone - Evaluate the significance and sensitivity to disturbance of the vegetation as fish habitat (feeding, spawning grounds, cover, etc.), and nesting and feeding habitat for wildlife (waterfowl, birds of prey, wading birds, moose, deer, beaver, muskrat, etc.). Disturbance may be due to recreational activities, weed removal, sand beach development, dock development or boating. In addition, removal of shade trees near the Shore Zone may result in changes to the existing fish and wildlife habitat.

On a separate Lake Site Base Map, create a Fish and Wildlife Habitat Ranking Map. On this map delineate and label habitat areas within each Lake Zone that has a low or high significance and sensitivity to disturbance.

(6) Evaluate Residential and Recreational Potential within the Lake Site

On a separate Lake Site Base Map, create a Residential and Recreation Theme Map. Delineate and label on this map features within each Lake Zone that pertain to their residential (Upland Zone outside the Lake

Environmental Buffer Strip) or recreational potential (Upland Zone within the buffer and other zones) - (Sources of Lake Information: site inspection, 1., 2., 3., 4., 6., 8., 10., 11., 12., 13.). Since a buffer of at least 30 metres in width is key to achieving a number of objectives (Section B.iv. and v.), it is imperative that the Lake Site's Upland Zone located more than 30 metres from the Shore Zone be the primary focus of study. This is in spite of the fact that an existing tentative subdivision plan may show proposed lots within 30 metres.

- Upland Zone - Delineate and label the location of any hilly areas (slopes greater than 15%) and any high water table areas within this zone. Furthermore, identify and label the positions of all water table and percolation test holes, and production and observation groundwater wells. Use Chapter 2 of these guidelines to evaluate household water supply and Chapter 3 to investigate water table and soil conditions.

- Escarpment Zone – Delineate and label any areas in this zone where there is active toe of slope erosion (wind and/or wave caused) or slope movement.

- Backshore Zone – Show the approximate depth to the water table at various locations and in particular, depict any areas where there is standing water, for example behind ice thrust ridges. Show the depth of inundation during a major flooding or storm event at various locations.

- Shore Zone – Delineate and label sediment composition (mud, sand, gravel etc.), concentrations of riparian vegetation (weeds), organic debris piles (logs, fallen trees, etc.), active wave erosion areas and ice thrust ridges.

- Littoral Zone – Delineate and label lake bottom sediment composition (mud, sand, gravel etc.), and concentrations of aquatic macrophytes (weeds) and debris (logs, fallen trees, etc.).

Referring to this map, describe these findings in the report.

In addition, for each Lake Zone, evaluate their residential (Upland Zone outside the buffer) or recreational potential (Upland Zone within the buffer and other zones).

- Upland Zone outside the buffer – Evaluate the residential potential of this part of the Upland Zone with respect to Suitable Development Areas and the potential for sewage effluent, grey water and lawn fertilizers to migrate to the lake thereby reducing water quality. Areas with high residential potential contain one or more Suitable Development Areas (Glossary) for lake residences and associated

ancillary buildings, household water supply systems and private sewage disposal systems. Household chemicals and wastes generated from within these Suitable Development Areas have a low potential to contaminate the lake.

As discussed above, use Chapter 2 of these guidelines to evaluate household water supply and Chapter 3 to investigate water table and soil conditions. Due to the integrative nature of the Lake Residential Subdivision Environmental Report, the groundwater supply and soils reports should be incorporated into it, probably as appendices.

- Upland Zone within the buffer - Evaluate the recreational potential of the one or more Upland Zone areas within the buffer with respect to the development and maintenance of footpaths and Lakeshore Recreation Areas. Areas that are level to moderately sloping, relatively dry (not wet and mucky) have a high recreational potential for these uses.

- Escarpment Zone – Evaluate the recreational potential of the one or more Escarpment Zone areas with respect to the development and maintenance of footpaths that might traverse it. Areas with high recreational potential are of relatively low height, are moderately sloping, exhibit no toe erosion and are stable.

- Backshore Zone – Evaluate the recreational potential of the one or more Backshore Zone areas with respect to the development and maintenance of footpaths and Lakeshore Recreation Areas. Areas that are minimally floodprone, narrow and relatively dry (not wet and mucky) have a high recreational potential for these uses.

- Shore Zone – Evaluate the recreational potential of the one or more Shore Zone areas for beach oriented activities such as sun tanning, picnicking, and walking. Generally, Shore Zone areas that are broad, gently sloping, sandy, not prone to significant wave or ice erosion, or ice thrusting, with minimal vegetation cover or organic debris piles, have a high recreational potential.

- Littoral Zone – Evaluate the recreational potential of the Littoral Zone for activities such as swimming, wading and boating.

The recreational potential for swimming and wading depends upon several factors including the characteristics of bottom sediments, aquatic vegetation, debris accumulation, bottom slope and water quality. Typically shallow areas exposed to wave action and with little or no aquatic vegetation will have coarser sediments like sand and gravel, and little debris. In contrast, well vegetated sheltered areas will likely trap finer sediments and therefore, have a muddy bottom. Generally, sparsely vegetated, firm bottomed, gently sloping, debris free Littoral Zone areas have a high recreational potential. With respect to water quality, the lake water should be safe (not a health hazard) for swimming or wading, clear and colourless.

The breadth and depth of the Littoral Zone within the Lake Zone may limit boating opportunities for the Lake Residential Subdivision residents. The Littoral Zone may be sufficiently broad and shallow to impede near shore boat movement and docking.

On a separate Lake Zones Base Map, create a Residential and Recreational Potential Ranking Map. On this map delineate and label areas within the Upland Zone outside the buffer that have a low or high residential potential. Similarly, for the Upland Zone within the buffer and the other Lake Zones delineate and label areas that have a low or high recreational potential.

(7) Composite Map

Based upon mapping and analysis in Steps (5) and (6) above, create a Composite Map using the Lake Zones Base Map as a starting point. Employing the completed Fish and Wildlife Habitat Ranking Map (Step (5)), and the Residential and Recreational Potential Ranking Map (Step (6)), delineate and label on the Composite Map two areas within the Upland Zone outside the buffer. The first area has a high residential potential (has Suitable Development Areas) but a low wildlife habitat ranking. The second area has a low residential potential (e.g. high water table areas). For the Upland Zone within the buffer, and the Escarpment, Backshore, Shore and Littoral Zones delineate and label two areas. The first area possesses a high fish and wildlife habitat ranking. The second area has a high recreational potential but a low fish and wildlife habitat ranking.

(8) Evaluate Potential Isolation of the Lake Site

Determine whether the Lake Site is isolated from the remainder of the lake with respect to boating. This may happen if the Lake Site is on a bay that has a mouth that is too narrow, shallow and/or weed choked to permit boat access to the remainder of the lake (Sources of Lake Information: site inspection, 1., 2., 6., 7., 8., 10., 12.).

(9) Evaluate the Overall Potential the Proposed Lake Residential Subdivision can meet the Environmental Objectives

Based upon the results of the preceding investigations and evaluations, determine the overall potential that the proposed Lake Residential Subdivision can meet the four environmental objectives (Section B.iv.). For a given lake, Lake Site and subdivision the overall potential can be rated as high, moderate or low.

For a proposed subdivision with a high potential, there are no environmental constraints to development and recreation posed by the lake or the Lake Site. Where a proposed subdivision has a moderate potential, the lake and/or the Lake Site has some limitations to development and recreation. With respect to the Lake Site, a portion of at least one Lake Zone consists of habitat that is significant and sensitive to disturbance, and/or is not environmentally suitable for development and/or recreation. However, despite these problems the configuration of the appropriate areas is conducive to one or more major subdivision designs (Section B.vii.(2)). A proposed subdivision has a low potential if the lake and/or Lake Site have one or more critical limitations to development and recreation. With regard to the Lake Site, one or more zones may be completely inappropriate for development and recreation, and/or appropriate areas associated with the various zones have an unfavourable arrangement relative to one another.

(10) Quality Assurance Statement in the Report

The subdivision authority needs high quality, trustworthy information to make a good decision. A poor study may result ultimately in unusable residential lots and/or deteriorated shore and lake conditions. To help ensure that the study is of professional quality, the consultants and any reviewers must sign and stamp (if applicable) the work and include a Quality Assurance Statement. The statement should assure the subdivision authority that the consultants have performed the evaluation in conformance with these guidelines.

If the report does not contain maps and evaluations requested under items (2) and (8) above, and/or a Quality Assurance Statement, the subdivision authority should identify this as a major deficiency and not proceed with the application until this has been remedied.

(11) Submission of the Report to the Subdivision Authority

The applicant should submit copies of the Lake Residential Subdivision Environmental Report, the Subdivision Groundwater Supply Report (Chapter 2), the Subdivision Soils Report (Chapter 3) and the Lake Residential Subdivision Tentative Plan to the subdivision authority (for more information on the tentative plan and referral procedure see Section D.iv.).

D. *Development of a Subdivision Plan Consistent with the Environmental and Supplementary Objectives and the Findings of the Environmental Report*

i. Introduction

This section discusses in detail the preparation and submission of the Lake Residential Subdivision Plan. It describes the procedure for hiring a qualified planning consultant, lists sources of available information, and discusses the development of Lake Residential Subdivision Tentative Plan.

ii. Hiring a Qualified Planning Consultant to Prepare a Subdivision Tentative Plan

It is the applicant's responsibility to select and hire a qualified planning consultant to prepare the subdivision tentative plan. The consultant may be a Alberta Land Surveyor, landscape architect, planner, etc. Consultants may be found in the Yellow Pages under Engineers Consulting, Engineers Environmental, Environmental Consultants, Land Planning Service, Landscape Architects and Surveyors Alberta Land. (see either the phone book or Telus Advertising Services' website – On-line Yellow Directories & Interactive Services http://www.alberta.com/). The Environmental Services Association of Alberta also has a lengthy directory of consultants (phone 1-800-661-9278 or view the association's website at http://www.esaa.org).

Due to the complexity of a Lake Residential Subdivision and the necessity that the tentative plan reflect the results of the Lake Residential Subdivision Environmental Report, it is desirable that the planner be a member of, or closely associated with, the team preparing the environmental report.

iii. Development of the Lake Residential Subdivision Tentative Plan

The design of the Lake Residential Subdivision should be based upon the environmental characteristics of the lake and Lake Site; and the environmental and supplementary objectives (Section B.iv. and B.v.). Therefore, it is crucial that the planner have a copy of the Lake Residential Environmental Report and the Composite Map (Section C.).

If a subdivision has a high or medium overall potential (Section C.iii.(9)), the planning consultant should develop a Lake Residential Subdivision Tentative Plan. The plan should be superimposed on the Composite Map (Section C.iii.(7)).

The consultant should endeavour to achieve the environmental and supplementary objectives through careful subdivision design. As has been discussed in the Section B.vii.(2) and (3), the preferred subdivision design is a cluster plan, especially where the proposed subdivision has a medium overall potential to meet the environmental objectives.

iv. Submission of the Lake Residential Subdivision Environmental Report and Tentative Plan

The applicant should submit copies of the Lake Residential Subdivision Environmental Report (Section C.) and the Lake Residential Subdivision Tentative Plan (Section D.iii.) to the subdivision authority (the groundwater supply and soils reports should be incorporated into the lake report). The subdivision authority will circulate the report and the tentative plan to a number of agencies for their comments. These include the municipality (if applicable), the appropriate regional Public Land's office and Regional Natural Resources Service office (Appendix F – Bed, Shore and Bank of a Naturally Occurring Body of Water for regional offices), the Water Data Management Section (Appendix H, Section D., Item (7)), and the Alberta Conservation Association (ACA).

Appendix A - Environmental References in the Municipal Government Act (Statutes of Alberta, 1994, Chapter M-26.1 - Consolidated October 2, 1995)

A. *Introduction*

This appendix presents verbatim major environmental references in the *Municipal Government Act*. References to the Act's *Subdivision and Development Regulation* may be found under specific subject headings throughout the Manual.

B. *Municipal Responsibility for Water Bodies (excerpt from section 60)*

60(1) Subject to any other enactment, a municipality has the direction, control and management of the rivers, streams, watercourses, lakes and other natural bodies of water within the municipality, including the air space above and the ground below.

C. *Transfer of a Parcel to a Municipality (excerpt from section 424)*

424(1) The municipality at whose request a tax recovery notification was endorsed on the certificate of title for a parcel of land may become the owner of a parcel after the public auction, if the parcel is not sold at the public auction.

D. *Purpose of Part 17 - Planning and Development (refer in particular to 617(b))*

617 The purpose of this Part and the regulations and bylaws under this Part is to provide means whereby plans and related matters may be prepared and adopted

(a) to achieve the orderly, economical and beneficial development, use of land and patterns of human settlement, and

(b) to maintain and improve the quality of the physical environment within which patterns of human settlement are situated in Alberta,

without infringing on the rights of individuals for any public interest except to the extent that is necessary for the overall greater public interest.

1995 c24 s95

E. Non-application of Part 17 - Planning and Development - to Certain Types of Development (excerpt from section 618)

618(1) This Part and the regulations and bylaws under this Part do not apply when a development or a subdivision is effected only for the purpose of

(a) a highway or road,

(b) a well or battery within the meaning of the *Oil and Gas Conservation Act*, or

(c) a pipeline or an installation or structure incidental to the operation of a pipeline.

F. Land Use Policies

622(1) The Lieutenant Governor in Council may by order, on the recommendation of the Minister, establish land use policies.

(2) The *Regulations Act* does not apply to an order under subsection (1).

(3) Every statutory plan, land use bylaw and action undertaken pursuant to this Part by a municipality, municipal planning commission, subdivision authority, development authority or subdivision and development appeal board or the Municipal Government Board must be consistent with the land use policies.

1995 c24 s95

G. Environmental Components of Statutory Plans

i. Intermunicipal Development Plan (excerpt from section 631)

631(2)(a)(iii) An intermunicipal development plan may provide for any other matter relating to the physical, social or economic development of the area that the councils consider necessary,

ii. Municipal Development Plan (excerpts from section 632)

632(3) A municipal development plan

(b) may address

(iii) environmental matters within the municipality,

(c) may contain statements regarding the municipality's development constraints, including the results of any development studies and impact analysis, and goals, objectives, targets, planning policies and corporate strategies,

(d) must identify the location of sour gas facilities and contain policies related to them that are compatible with the subdivision and development regulations,

H. Environmental Components of Land Use Bylaws (excerpts from section 640)

640(1) A land use bylaw may prohibit or regulate and control the use and development of land and buildings in a municipality.

(2) A land use bylaw

(a) must divide the municipality into districts of the number and area the council considers appropriate;

(e) must establish the number of dwelling units permitted on a lot.

(4) Without restricting the generality of subsection (1), a land use bylaw may provide for one or more of the following matters, either generally or with respect to any district or part of a district established pursuant to subsection (2)(a):

(a) subdivision design standards;

(b) the ground area, floor area, height, size and location of buildings;

(c) the amount of land to be provided around or between buildings;

(d) the landscaping of land or buildings;

(h) the location and amount of access to lots from roads and ensuring that there is at least one means of access from each lot to a road;

(j) the enlargement, alteration, repair, removal or relocation of buildings;

(k) the excavation or filling in of land;

(l) the development of buildings

(i) on land subject to flooding or subsidence or that is low lying, marshy or unstable,

(ii) on land adjacent to or within a specified distance of the bed and shore of any lake, river, stream or other body of water, or

(iii) subject to regulations made under section 693 or 694, within a specified area around an airport;

(o) the density of population in any district or part of it;

I. Approval of a Subdivision Application - Suitability of Land for the Purpose for which the Subdivision is Intended (excerpt from section 654)

654(1)(a) A subdivision authority must not approve an application for subdivision approval unless the land that is proposed to be subdivided is, in the opinion of the subdivision authority, suitable for the purpose for which the subdivision is intended,

J. Conditions of subdivision approval (excerpts from section 655)

655(1) A subdivision authority may impose the following conditions or any other conditions permitted to be imposed by the subdivision and development regulations on a subdivision approval issued by it:

(a) any conditions to ensure that this Part and the statutory plans and land use bylaws and the regulations under this Part affecting the land proposed to be subdivided are complied with;

(b) a condition that the applicant enter into an agreement with the municipality to do any or all of the following:

(i) to construct or pay for the construction of a road required to give access to the subdivision;

(ii) to construct or pay for the construction of

(A) a pedestrian walkway system to serve the subdivision, or

(B) pedestrian walkways to connect the pedestrian walkway system serving the subdivision with a pedestrian walkway system that serves or is proposed to serve an adjacent subdivision,

or both;

(iii) to install or pay for the installation of public utilities, other than telecommunications systems or works, that are necessary to serve the subdivision;

(2) A municipality may register a caveat under the Land Titles Act in respect of an agreement under subsection (1)(b) against the certificate of title for the parcel of land that is the subject of the subdivision.

(3) If a municipality registers a caveat under subsection (2), the municipality must discharge the caveat when the agreement has been complied with.

1995 c24 s95

K. Environmental Reserve

i. Reserves not required

663 A subdivision authority may not require the owner of a parcel of land that is the subject of a proposed subdivision to provide reserve land or money in place of municipal reserve, school reserve or municipal and school reserve if

(a) one lot is to be created from a quarter section of land,

(b) land is to be subdivided into lots of 16.0 hectares or more and is to be used for only agricultural purposes,

(c) the land to be subdivided is 0.8 hectares or less, or

(d) reserve land, environmental reserve easement or money in place of it was provided in respect of the land that is the subject of the proposed subdivision under this Part or the former Act.

ii. Environmental Reserve

664(1) A subdivision authority may require the owner of a parcel of land that is the subject of a proposed subdivision to provide part of that parcel of land as environmental reserve if it consists of

(a) a swamp, gully, ravine, coulee or natural drainage course,

(b) land that is subject to flooding or is, in the opinion of the subdivision authority, unstable, or

(c) a strip of land, not less than 6 metres in width, abutting the bed and shore of any lake, river, stream or other body of water for the purpose of

(i) preventing pollution, or

(ii) providing public access to and beside the bed and shore.

(2) If the owner of a parcel of land that is the subject of a proposed subdivision and the municipality agree that any or all of the land that is to be taken as environmental reserve is instead to be the subject of an environmental reserve easement, a caveat may be registered against the land in favour of the municipality at a land titles office.

(3) The environmental reserve easement must

(a) identify which part of the parcel of land the easement applies to, and

(b) require that land that is subject to the easement remain in a natural state as if it were owned by the municipality

1995 c24 s95

iii. Designation of Municipal Land (excerpt from section 665)

665(1) A council may, by bylaw, require that a parcel of land or a part of a parcel of land that it owns or that it is in the process of acquiring be designated as municipal reserve, school reserve, municipal and school reserve, environmental reserve or public utility lot.

(2) Subject to subsection (3), on receipt of a copy of a bylaw under this section and the applicable fees, the Registrar must do all things necessary to give effect to the order, including cancelling the existing certificate of title and issuing a new certificate of title for each newly created parcel of land with the designation of

(c) environmental reserve, which must be identified by a number suffixed by the letters "ER",

(3) The certificate of title for a municipal reserve, school reserve, municipal and school reserve, environmental reserve or public utility lot under this section must be free of all encumbrances, as defined in the *Land Titles Act*.

1995 c24 s95

iv. Use of Reserve Land, Money (excerpt from Section 671)

671(1) Subject to section 676(1), environmental reserve must be left in its natural state or be used as a public park.

v. Changes to Environmental Reserves' Use or Boundaries

676(1) A council may, by bylaw, after giving notice in accordance with section 606 and holding a public hearing in accordance with section 230,

(a) use an environmental reserve for a purpose not specified in section 671(1),

(b) transfer an environmental reserve to the Crown or an agent of the Crown for consideration, as agreed,

(c) lease or dispose of an environmental reserve other than by a sale for a term of not more than 3 years, and

(d) change the boundaries of an environmental reserve or environmental reserve easement in order to correct an omission, error or other defect in the certificate of title, or to rectify an encroachment problem or other concern.

(2) A council may include terms and conditions in a bylaw under subsection (1).

(3) Any proceeds from a lease or other disposition under subsection (1) may be used only to provide land for any or all of the purposes referred to in section 671(2).

(4) On receipt of a bylaw under subsection (l)(b) or (d), the Registrar must cancel the existing certificates of title or amend an environmental reserve easement affected by the bylaw and issue any new certificates of title required by the bylaw.

1995 c24 s95

vi. Road, etc. over Reserve Land

677 Notwithstanding section 671, a municipality or a municipality and a school authority may authorize

(a) the construction, installation and maintenance or any of them of a road, public utility, pipeline as defined in the *Oil and Gas Conservation Act* or transmission line as defined in the *Hydro and Electric Energy Act* on, in, over or under reserve land, or

(b) the maintenance and protection of reserve land.

if the interests of the public will not be adversely affected.

1995 c24 s95

Appendix B - Environmental References in the Subdivision and Development Regulation

A. *Introduction*

This appendix presents verbatim selected environmental references in the *Subdivision and Development Regulation* of the *Municipal Government Act*. A number of provisions within Part 1 - Subdivision Applications, of the Regulation support requests by a subdivision authority for information on site conditions. This information will assist a subdivision authority to determine whether or not the land to be subdivided is suitable for the purpose for which the subdivision is intended (section 654(1)(a) of the *Municipal Government Act*; refer to Appendix A.I. of this report).

B. *Minimum Mapping Requirements for Subdivision Applications*

4(4) The applicant must submit the number of sketches or plans of the proposed subdivision drawn to the scale that the subdivision authority requires

(a) showing the location, dimensions and boundaries of the land to be subdivided,

(b) clearly outlining the land that the applicant wishes to register in a land titles office,

(c) showing the location, dimensions and boundaries of

(i) each new lot to be created, and any reserve land, and

(ii) existing rights of way of each public utility, or other rights of way,

(d) showing the location, use and dimensions of buildings on the land that is the subject of the application and specifying those buildings that are proposed to be demolished or moved,

(e) showing the approximate location and boundaries of the bed and shore of any river, stream, watercourse, lake or other body of water that is contained within or bounds the proposed parcel of land,

(f) describing the use or uses proposed for the land that is the subject of the application,

(g) if the proposed lots are to be served by individual wells and private sewage disposal systems, showing the location of any existing or proposed wells, the location and type of any private sewage disposal systems and the distance from these to existing or proposed buildings and property lines, and

(h) showing the existing and proposed access to the proposed parcels and the remainder of the titled area.

C. *Additional Environmental Reports and Maps that a Subdivision Authority may Require an Applicant to Submit*

4(5) The subdivision authority may require an applicant for subdivision to submit, in addition to a complete application for subdivision, all or any of the following:

(a) a map of the land that is to be subdivided and shows topographic contours at not greater than 1.5 metre intervals and related to the geodetic datum, where practicable;

(b) if a proposed subdivision is not to be served by a water distribution system, information supported by the report of a person qualified to make it, respecting the provision, availability and suitability of potable water on or to the land to be subdivided;

(c) an assessment of subsurface characteristics of the land that is to be subdivided including but not limited to susceptibility to slumping or subsidence, depth to water table and suitability for any proposed on site sewage disposal system;

(d) if the land that is the subject of an application is located in a potential flood plain and flood plain mapping is available, a map showing the 1:100 flood;

(e) if a proposed subdivision is not to be served by a wastewater collection system, information supported by the report of a person qualified to make it, respecting the intended method of providing sewage disposal facilities to each lot in the proposed subdivision;

(f) information respecting the land use and land surface characteristics of land within 0.8 kilometres of the land proposed to be subdivided;

(g) if any portion of the parcel of land affected by the proposed subdivision is situated within 1.5 kilometres of a sour gas facility, a map showing the location of the sour gas facility;

(h) a conceptual scheme that relates the application to future subdivision and development of adjacent areas;

(i) any additional information required by the subdivision authority to determine whether the application meets the requirements of section 654 of the Act.

D. *Provisions Relating to the Referral of Subdivision Applications to Alberta Environmental Protection (excerpts from section 5)*

5(2) For the purposes of subsection (3)(e)(ii), the Deputy Minister responsible for administration of the *Public Lands Act* may, in an agreement with a municipality, further define the term "body of water" but the definition does not include dugouts, drainage ditches, man made lakes or other similar man made bodies of water.

5(3) On receipt of a complete application for subdivision, the subdivision authority must send a copy to

(b) the Deputy Minister of the Department of Environmental Protection if any of the land that is subject of an application is within the distances referred to in section 12 or 13;

(e) the Deputy Minister of the Minister responsible for administration of the *Public Lands Act* if the proposed parcel

(i) is bounded by the bed and shore of a river, stream, watercourse, lake or other body of water, or

(ii) contains, either wholly or partially, the bed and shore of a river, stream, watercourse, lake or other body of water;

(f) the Deputy Minister of the Minister responsible for the administration of the *Public Lands Act*, if the land that is the subject of the application is within the Green Area, being that area established by Ministerial Order under section 10 of the *Public Lands Act* dated May 7, 1985, as amended or replaced from time to time except that for the purposes of this Regulation, the Green Area does not include,

(i) land within an urban municipality, and

(ii) any other lands that the Deputy Minister of the Minister responsible for the administration of the Public Lands Act states, in writing, may be excluded;

(h) the Deputy Minister of Environmental Protection if the land is situated within a Restricted Development Area established under Schedule 5 of the *Government Organization Act*;

E. Environmental Factors a Subdivision Authority must consider when making a Decision on a Subdivision Application

7 In making a decision as to whether or not to approve an application for subdivision, the subdivision authority must consider, with respect to the land that is subject of the application,

(a) its topography,

(b) its soil characteristics,

(c) storm water collection and disposal,

(d) any potential for the flooding, subsidence or erosion of the land,

(e) its accessibility to a road,

(f) the availability and adequacy of a water supply, sewage disposal system and solid waste disposal,

(g) in the case of land not serviced by a licensed water distribution and wastewater collection system, whether the proposed subdivision boundaries, lot sizes and building sites comply with the requirements of the *Plumbing Code Regulation* (Alta. Reg. 211/92) in respect of lot size and distances between property lines, buildings, water sources and private sewage disposal systems,

(h) the use of land in the vicinity of the land that is the subject of the application, and

(i) any other matters that it considers necessary to determine whether the land that is the subject of the application is suitable for the purpose for which the subdivision is intended.

F. Distance from a Wastewater Treatment Plant

12(1) In this section, "working area" means those areas of a parcel of land that are currently being used or will be used for the processing of wastewater.

(2) A subdivision authority must not approve an application for subdivision for school, hospital, food establishment or residential use unless, on considering the matters referred to in section 7, each proposed lot includes a suitable building site for school, hospital, food establishment or residential use 300 metres or more from the working area of an operating wastewater treatment plant.

(3) Subject to subsection (5), a development authority must not issue a development permit for a school, hospital, food establishment or residential building within 300 metres of the working area of an operating wastewater treatment plant nor may a residential building be constructed within 300 metres of the working area of an operating waste water treatment plant.

(4) Subject to subsection (5), a subdivision authority must not approve an application for subdivision and a development authority may not issue a permit for the purposes of developing a wastewater treatment plant unless the working area of the wastewater treatment plant is situated at least 300 metres from any school, hospital, food establishment or residential building or proposed school, hospital, food establishment or residential building site.

(5) The requirements contained in subsections (2) to (4) may be varied by a subdivision authority or a development authority with the written consent of the Deputy Minister of the Department of Environmental Protection.

(6) A consent under subsection (5) may refer to applications for subdivision or development generally or to a specific application.

G. *Distance from a Landfill, Waste Sites*

13(1) In this section,

(a) "disposal area" means those areas of a parcel of land that have been used and will not be used again for the placing of waste material or where waste processing or a burning activity is conducted in conjunction with a sanitary landfill, modified sanitary landfill, hazardous waste management facility or dry waste site;

(b) "working area" means those areas of a parcel of land that are currently being used or that still remain to be used for the placing of waste material or where waste processing or a burning activity is conducted in conjunction with a sanitary landfill, modified sanitary landfill, dry waste site, hazardous waste management facility, waste processing site, waste sorting station or waste transfer station.

(2) Subject to subsection (5), a subdivision authority must not approve an application for subdivision for a school, hospital, food establishment or residence if the application would result in the creation of a building site for any of those uses

(a) within 450 metres of the working area of an operating sanitary landfill, modified sanitary landfill, hazardous waste management facility or dry waste site,

(b) within 300 metres of the disposal area of an operating or non-operating sanitary landfill, modified sanitary landfill or dry waste site,

(c) within 450 metres of the disposal area of a non-operating hazardous waste management facility, or

(d) within 300 metres of the working area of an operating waste processing site, waste storage site, waste sorting station or waste transfer station.

(3) Subject to subsection (5), a development authority must not issue a development permit for a school, hospital, food establishment or residence nor may a residence be constructed if the building site

(a) is within 450 metres of the working area of an operating sanitary landfill, modified sanitary landfill, hazardous waste management facility or dry waste site,

(b) is within 300 metres of the disposal area of an operating or non-operating sanitary landfill, modified sanitary landfill or dry waste site,

(c) is within 450 metres of the disposal area of a non-operating hazardous waste management facility, or

(d) is within 300 metres of the working area of an operating waste processing site, waste storage site, waste sorting station or waste transfer station.

(4) Subject to subsection (5), a subdivision authority must not approve an application for subdivision, and a development authority must not issue a permit for the purposes of developing

(a) a sanitary landfill, modified sanitary landfill or dry waste site,

(b) a hazardous waste management facility, or

(c) a waste processing site, waste storage site, waste sorting station or waste transfer station

unless

(d) the working area of the things referred to in clause (a) is situated at least 450 metres,

(e) the disposal area of things referred to in clause (a) is situated at least 300 metres,

(f) the working or disposal area of things referred to in clause (b) is situated at least 450 metres, and

(g) the working area of things referred to in clause (c) is situated at least 300 metres

from the property line of a school, hospital, food establishment or residence or site proposed for a hospital, food establishment or residence.

(5) The requirements contained in subsections (1) to (4) may be varied by a subdivision authority or a development authority with the written consent of the Deputy Minister of the Department of Environmental Protection.

(6) A consent under subsection (5) may refer to applications for subdivision or development generally or to a specific application.

Appendix C - Selected References from the Land Use Policies – Municipal Government Act

A. *Introduction*

This appendix presents verbatim selected references in the *Land Use Policies*. These policies received the approval of the Lieutenant Governor in Council on November 6, 1996 (Order in Council 522/96) and were established pursuant to section 622 of the *Municipal Government Act* (refer to Appendix A, Section F.*)*. The policies help municipalities harmonize provincial and municipal policy initiatives at the local land use planning level, and supplement the planning provisions of the *Municipal Government Act* and its *Subdivision and Development Regulation*.

References have been selected to provide a general understanding of the policies, and in particular, highlight components that relate to the environment. Sections 1.0 (Introduction), 5.0 (The Natural Environment), and 6.0 (Resource Conservation) are complete with no omissions. Only some of the provisions of sections 2.0 (The Planning Process), 3.0 (Planning Cooperation) and 4.0 (Land Use Patterns) are included. There is no reference to sections 7.0 (Transportation) or 8.0 (Residential Development).

B. *Selected References in the Land Use Policies*

1.0 INTRODUCTION

Land use planning is both a municipal and provincial activity. Municipalities are given responsibilities under Part 17 of the *Municipal Government Act*. A number of provincial departments and agencies are also involved as a result of their particular mandates. The Province's responsibility, with certain exceptions, extends to managing air, water, and renewable and non-renewable natural resources. Provincial legislation, policies, and programs for land use planning and resource management can affect municipal interests. Conversely, municipal decisions and actions affecting land use and development can impact on the success of provincial objectives designed for the benefit of all Albertans.

It is therefore important that municipal and provincial planning efforts utilize consistent approaches and pursue a high level of cooperation and coordination. It is also important that municipal planning efforts complement provincial policies and initiatives, especially as municipalities adjust to the changing planning structure and their additional responsibilities in keeping with the new planning legislation. The *Land Use Policies* are therefore being established pursuant to section 622 of the *Municipal Government Act*. The *Land Use Policies* supplement the planning provisions of the *Municipal Government Act* and the Subdivision and Development Regulation. It is expected that all municipalities will implement these policies in the course of carrying out their planning responsibilities.

There are eight sections to the *Land Use Policies*. Section 1 sets out the purpose of the *Land Use Policies* and clarifies the implementation role of municipalities. Sections 2 and 3 contain policies which are operational in nature and which relate to a municipality's general approach to planning and to municipal interaction with residents, applicants, neighbouring municipalities, provincial and federal departments and other jurisdictions. Sections 4 to 8 contain policies which address specific land use planning issues in which the Province and municipalities share a common interest.

1.1 Implementation

Each municipality is expected to incorporate the *Land Use Policies* into its planning documents and planning practices. Section 622(3) of the *Municipal Government Act* requires that municipal statutory plans, land use bylaws, and planning decisions and actions be consistent with the Land-Use Policies. Section 680(2)(c) requires a subdivision and development appeal board and the Municipal Government Board[1] to be consistent with the *Land Use Policies* in determining a subdivision appeal. Section 687(3)(a) requires a subdivision and development appeal board to comply with the *Land Use Policies* in determining a development appeal.

The policies in sections 2 and 3 are particularly relevant to the design of planning programs, the formulation of statutory plans and land use bylaws, and the planning decision-making process. The policies in sections 4 to 8 have particular application to the content of statutory plans and land use bylaws, as well as to the nature of planning decisions.

The *Municipal Government Act* (Part 17) requires many municipalities to prepare a new municipal development plan or to review and revise an existing general municipal plan to bring it into conformance with the new legislation.[2] It also requires that all land use bylaws be reviewed and most be revised.[3] Municipalities may also be embarking on the preparation of other statutory plans such as intermunicipal development plans. As existing planning documents are being reviewed and revised, and as new ones are being prepared, municipalities are required to ensure that their plans and bylaws are consistent with the *Land Use Policies*.

The *Municipal Government Act* (Part 17) also establishes a relationship between the *Land Use Policies* and planning decisions by municipalities.[4] The Province recognizes that not all policies are relevant to all planning decisions.

The Province also recognizes that once statutory plans and land use bylaws are consistent with the *Land Use Policies*, sections 5 to 8 of the policies will have largely been implemented. Municipalities are expected to design a decision making system which ensures that the required attention is given to all sections of the *Land Use Policies*.

1 The wording of the *Land Use Policies* is oriented towards municipalities. Municipal Government Board decisions pursuant to Part 17 of the *Municipal Government Act* are also required to be consistent with their spirit, intent, and direction.

2 See sections 632 and 707 of the *Municipal Government Act*.

3 See sections 639 and 708 of the *Municipal Government Act*.

4 The term is used in the broad sense and includes council, administration, designated officers, commissions, committees, boards, and authorities.

1.2 Interpretation

The Province is entrusting to each municipality the responsibility to interpret and apply the *Land Use Policies* and to further elaborate on the policy initiatives in its statutory plans and land use bylaws. The policies are presented in a general manner which allows municipal interpretation and application in a locally meaningful and appropriate fashion. Municipalities and provincial departments and agencies are encouraged to consult with one another where questions on the spirit and intent of these policies arise during implementation.

The *Land Use Policies* focus on matters of public policy, not matters of law. They provide a framework for statutory plans, land use bylaws, and planning decisions. The *Land Use Policies* should be interpreted as a guide to more specific municipal policy and action, and are not intended to be the basis of legal challenges. In applying the *Land Use Policies* municipalities must assess the importance of each policy in relation to the others in light of local and intermunicipal priorities. Municipalities must have regard to the cumulative effect of all of the policies as well as to the specific effect of each policy.

2.0 THE PLANNING PROCESS (excerpts)

Goal

Planning activities are to be carried out in a fair, open, considerate, and equitable manner.

Policies

3. When considering a planning application, municipalities are expected to have regard to both site specific and immediate implications and to long term and cumulative benefits and impacts.

3.0 PLANNING COOPERATION (excerpts)

Goal

To foster cooperation and coordination between neighbouring municipalities and between municipalities and provincial departments and other jurisdictions in addressing planning issues and in implementing plans and strategies.

Policies

1. Municipalities are encouraged to expand intermunicipal planning efforts to address common planning issues, especially where valued natural features are of interest to more than one municipality and where the possible effect of development transcends municipal boundaries.

5. Where two or more municipalities are located on the shores of the same lake, and development is anticipated, the municipalities are encouraged to prepare, adopt, and implement an intermunicipal development plan to jointly address lake planning issues.

6. Municipalities are encouraged to coordinate their planning activities and development approval processes with provincial resource and land management policies, such as integrated resource plans, and with provincial leasing mechanisms, such as the Alberta Tourism Recreational Lease Process.

7. Municipalities are encouraged to work directly with provincial land and resource management agencies in the development of plans and policies on issues of mutual interest. Decisions and approvals affecting land use and development on, near, or with potential to impact provincial resources[5] should be coordinated between these levels of government.

5 Provincial resources include water, air, provincially-owned mineral resources, fish and wildlife, beds and shores of provincially-owned water bodies and watercourses (pursuant to section 3 of the Public Lands Act), provincially-owned lands, and timber resources on provincial lands.

4.0 LAND USE PATTERNS (excerpts)

Goal

To foster the establishment of land use patterns which make efficient use of land, infrastructure, public services, and public facilities; which promote resource conservation; which enhance economic development activities; which minimize environmental impact; which protect significant natural environments; and which contribute to the development of healthy, safe, and viable communities.

Policies

1. Municipalities are encouraged to establish, on a municipal and on an intermunicipal basis, land use patterns which provide an appropriate mix of agricultural, residential, commercial, industrial, institutional, public and recreational land uses developed in an orderly, efficient, compatible, safe and economical manner in keeping with the general policies of this section and the more specific policies found in sections 5.0 to 8.0.

2. Municipalities are encouraged to establish land use patterns which embody the principles of sustainable development, thereby contributing to a healthy environment, a healthy economy and a high quality of life.[6]

4. Municipalities are encouraged to establish land use patterns which accommodate natural resource extraction or harvesting and processing, manufacturing and other industrial development while, at the same time, minimizing potential conflict with nearby land uses and any negative environmental impact.

5. Municipalities are encouraged to establish land use patterns which provide the opportunity for a variety of residential environments which feature innovative designs and densities, and which make efficient use of existing facilities, infrastructure and public transportation.

6. Municipalities are encouraged to establish land use patterns commensurate with the level of infrastructure and services which can be provided, regardless of whether the infrastructure and services are provided municipally, communally, individually, or by a utility company. Municipalities are encouraged to coordinate the provision of infrastructure and services with neighbouring municipalities.

6 The Alberta Vision of Sustainable Development was endorsed by the Alberta Legislature in June 1992. A summary is found in Appendix 1. Municipalities should refer to the publications:
1. Alberta Round Table on Environment and Economy 1991 (#P5-El).
2. Report of Alberta Round Table on Environment and Economy 1993 (#P5-E2).
3. Ensuring Prosperity, Implementing Sustainable Development 1995 (#592-E-1).
Publications are available from the Environmental Protection Information Centre, 9920 - 108 Street, Edmonton, AB T5K 2M4. Telephone: (403) 422-2079.

5.0 THE NATURAL ENVIRONMENT

Goal

To contribute to the maintenance and enhancement of a healthy natural environment.[8]

Policies

1. Municipalities are encouraged to identify, in consultation with Alberta Environmental Protection,[9] significant ravines, valleys, stream corridors, lakeshores, wetlands[10] and any other unique landscape area, and to establish land use patterns in the vicinity of these features, having regard to their value to the municipality and to the Province.

2. If subdivision and development is to be approved in the areas identified in accordance with policy #1 municipalities are encouraged to, within the scope of their jurisdiction, utilize mitigative measures designed to minimize possible negative impacts.[11]

3. Municipalities are encouraged to identify, in consultation with Alberta Environmental Protection, areas which are prone to flooding, erosion, landslides, subsidence, or wildfire and to establish appropriate land use patterns within and adjacent to these areas.

4. If subdivision and development is to be approved in the areas identified in accordance with policy #3 municipalities are encouraged to, within the scope of their jurisdiction, utilize mitigative measures to minimize the risk to health, to safety, and to loss due to property damage.[12]

5. Municipalities are encouraged to identify, in consultation with Alberta Environmental Protection, areas of significant fish, wildlife and plant habitat and to establish appropriate land use patterns designed to minimize the loss of valued habitat within and adjacent to these areas.[13]

6. If subdivision and development is to be approved in the areas identified in accordance with policy #5 municipalities are encouraged to, within the scope of their jurisdiction, utilize mitigative measures to minimize the loss of habitat.

8 Municipalities should refer to Alberta Environmental Protection's Vision Statement, which promotes shared stewardship of the natural environment and of renewable natural resources. Copies may be obtained from the Environmental Protection Information Centre. 9920 - 108 Street, Edmonton AB T5K 2M4. Telephone: (403) 422-2079.

9 Pursuant to section 3 of the Public Lands Act, the ownership of public lands including permanent and naturally occurring water bodies and water features rests with the Minister of Environmental Protection (AEP). Public Lands of Alberta Agriculture, Food and Rural Development is responsible for the management of these resources in the White Area. In the Green Area, the Land and Forest Service (AEP) is the management authority. Please note that throughout this document Alberta government departments are referred to by the name in common usage rather than the legal name (e.g., Alberta Environmental Protection not Department of Environmental Protection).

10 Wetland areas are valued for water storage, groundwater replenishment, flow regulation. water quality control, and wildlife habitat. Municipalities should refer to Wetland Management for Alberta, an Interim Policy, 1993, available from the Environmental Protection Information Centre, 9920 - 108 Street, Edmonton, AB T5K 2M4. Telephone: (403) 422-2079.

11 Municipalities should refer to the Environmental Reference Manual for the Review of Proposed Subdivisions in Alberta, available from the Environmental Protection Information Centre, 9920 - 108 Street, Edmonton, AB T5K 2M4. Telephone: (403) 422-2079.

12 Municipalities should refer to the Environmental Reference Manual for the Review of Proposed Subdivisions in Alberta, available from the Environmental Protection Information Centre, 9920 - 108 Street, Edmonton, AB T5K 2M4. Telephone: (403) 422-2079.

13 Municipalities should refer to the Canadian Biodiversity Strategy: Canada's Response to the Convention on Biological Diversity (1995) available from the Environmental Protection Information Centre, 9920 - 108 Street, Edmonton, AB T5K 2M4. Telephone: (403) 422-2079. The Government of Alberta endorsed the strategy in January 1996.

6.0 RESOURCE CONSERVATION

6.1 Agriculture

Goal

To contribute to the maintenance and diversification of Alberta's agricultural industry.

Policies

1. Municipalities are encouraged to identify, in consultation with Alberta Agriculture, Food and Rural Development, areas where agricultural activities, including extensive and intensive agricultural and associated activities, should be a primary land use.

2. Municipalities are encouraged to limit the fragmentation of agricultural lands and their premature conversion to other uses, especially within the agricultural areas identified in accordance with policy #1.

3. Where possible, municipalities are encouraged to direct non-agricultural development to areas where such development will not constrain agricultural activities.

4. Municipalities are encouraged to minimize conflicts between intensive agricultural operations and incompatible land uses through the use of reciprocal setback distances[14] and other mitigative measures.

14 Municipalities are encouraged to utilize, in consultation with Alberta Agriculture, Food and Rural Development, the Minimum Distance Separation (MDS) method. The MDS method is applied in conjunction with the intensive livestock definition provided in the Code of Practice for the Safe and Economic Handling of Animal Manures.

6.2 Non-renewable Resources

Goal

To contribute to the efficient use of Alberta's non-renewable resources.

Policies

1. Municipalities are encouraged to identify, in consultation with the appropriate provincial land management agency and the Alberta Geological Survey, areas where the extraction of surface materials (e.g., sand and gravel) should be a primary land use.

2. Municipalities are encouraged to identify, in consultation with Alberta Energy, areas where the extraction of mineral resources should be a primary land use.[15]

3. Municipalities are encouraged to direct subdivision and development activity so as not to constrain or conflict with non-renewable resource development, particularly with respect to the areas identified in accordance with policies #1 and #2.

4. In addressing resource development municipalities are expected to, within the scope of their jurisdiction, utilize mitigative measures to minimize possible negative impacts on surrounding areas and land uses.

15 In the case of public land, municipalities should also consult Alberta Environmental Protection in the Green Areas and Alberta Agriculture, Food and Rural Development in the White Areas. (See also footnote #8).

6.3 Water Resources

Goal

To contribute to the protection and sustainable utilization of Alberta's water resources, including lakes, rivers, and streams, their beds and shores, wetlands, groundwater, reservoirs, and canals.

Policies

1. Municipalities are encouraged to identify, in consultation with Alberta Environmental Protection, significant water resources within their boundaries.

2. Municipalities are encouraged to determine appropriate land use patterns in the vicinity of the resources identified in accordance with policy #1, having regard to impacts on an entire watershed as well as local impacts.

3. If subdivision and development is to be approved in the vicinity of the resources identified in accordance with policy #1, municipalities are encouraged to, within the scope of their jurisdiction, incorporate measures which minimize or mitigate any negative impacts on water quality, flow and supply deterioration, soil erosion, and ground water quality and availability. Municipalities are also encouraged to facilitate public access and enjoyment of these water features, and to protect sensitive fisheries habitat and other aquatic resources.

6.4 Historical Resources

Goal

To contribute to the preservation, rehabilitation and reuse of historical resources, including archeological and palaeontological resources.[16]

Policies

1. Municipalities are encouraged to identify, in consultation with Alberta Community Development, significant historical resources within their boundaries.

2. Within the scope of their jurisdiction, municipalities are encouraged to contribute to the preservation and enhancement of the historical resources identified in accordance with policy #1 so that those resources may be used and enjoyed by present and future generations.[17]

16 Subject to section 28(2) and (3) of Historical Resources Act, all archeological and palaeontological resources are owned by the province.

17 Municipalities may wish to utilize sections 22 and 23 of the Historical Resources Act.

APPENDIX 1

Excerpt from Alberta's Vision of Sustainable Development
(see Section 4.0 Land Use Patterns, Policy #2)

Alberta, a member of the global community, is a leader in sustainable development, ensuring a healthy environment, a healthy economy, and a high quality of life in the present and the future.

Our vision encompasses all of the following elements:

The quality of the air, water, and land is assured.

Alberta's biological diversity is preserved.

We live within Alberta's natural carrying capacity.

The economy is healthy.

Market forces and regulatory systems work for sustainable development.

Urban and rural communities offer a healthy environment for living.

Albertans are educated and informed about the economy and the environment.

Albertans are responsible global citizens.

Albertans are stewards of the environment and the economy.

Appendix D - Selected References from the Water Act (awaiting proclamation)

A. *Introduction*

This appendix presents verbatim major environmental references in the *Water Act* (assented to September 3, 1996, awaiting proclamation). The majority of the selected references pertain to the evaluation of a residential subdivision's groundwater supply, Chapter 2. Section 96(1) of the *Water Act* deals with Flood Risk Areas and is of relevance to the flooding and erosion guidelines, Chapter 4.

B. *Interpretation in this Act (excerpts from 1(1))*

1(1) In this Act,

(c) "adverse effect" means impairment of or damage to;

(g) "approved water management plan" means a water management plan that is approved under Part 2;

(h) "aquatic environment" means the components of the earth related to, living in or located in or on water or the beds or shores of a water body, including but not limited to

(i) all organic and inorganic matter, and

(ii) living organisms and their habitat, including fish habitat, and their interacting natural systems;

(i) "aquifer" means an underground water-bearing formation that is capable of yielding water;

(n) "diversion of water" means

(i) the impoundment, storage, consumption, taking or removal of water for any purpose, except the taking or removal for the sole purpose of removing an ice jam, drainage, flood control, erosion control or channel realignment, and

(ii) any other thing defined as a diversion in the regulations for the purposes of this Act;

(q) "driller" means a person who is authorized under this Act to drill or reclaim a water well;

(w) "groundwater" means all water under the surface of the ground whether in liquid or solid state;

(x) "household" means a household as defined in the regulations for the purposes of this Act;

(y) "household purposes" means the use of a maximum of 1250 cubic metres of water per year per household for the purposes of human consumption, sanitation, fire prevention and watering animals, gardens, lawns and trees;

(z) "household user" means a person who is entitled to divert water for household purposes, as described in section 21;

(ddd) "traditional agriculture user" means a person who is entitled to divert water pursuant to section 24;

(jjj) "water guideline" means a water guideline established by the Minister under Part 2;

(kkk)"water management plan" means a plan with respect to conservation and management of water developed under Part 2;

(lll) "water well" means an opening in the ground, whether drilled or altered from its natural state, that is used for

(i) the production of groundwater for any purpose,

(ii) obtaining data on groundwater, or

(iii) recharging an underground formation from which groundwater can be recovered,

and includes any related equipment, buildings, structures and appurtenances;

C. Water management plans

9(1) The Minister may require a water management plan to be developed by the Director or another person.

(2) The Director or other person developing a water management plan

(a) may adopt an integrated approach to planning with respect to water, land and other resources;

(b) may co-operate with

(i) any persons,

(ii) local authorities,

(iii) Government agencies and other Government departments, and

(iv) the governments and government agencies of other jurisdictions;

(c) may, with the consent of the Minister, carry out any studies that the Director or other person considers appropriate;

(d) may consider any information, documents or other water and land management plans;

(e) must follow the framework for water management planning established under this Division;

(f) must engage in public consultation that the Minister considers appropriate during the development of the water management plan.

D. Water management planning areas

10 The Minister may establish water management planning areas for the purpose of developing or implementing a water management plan or approved water management plan.

E. Approved water management plans

11(1) The Lieutenant Governor in Council may approve a water management plan or part of a water management plan, subject to any terms and conditions that the Lieutenant Governor in Council considers appropriate.

(2) Notwithstanding subsection (1), the Lieutenant Governor in Council may authorize the Minister to approve a water management plan or part of a water management plan with respect to an area of the Province, subject to the conditions that the Minister considers appropriate.

(3) A water management plan that has been approved under this section is an approved water management plan and

(a) must include

(i) a summary of the issues considered in the water management plan,

(ii) a description of the area of the Province to which all or part of the water management plan applies,

(iii) a summary of the recommendations of the Minister, and

(iv) the matters or factors that must be considered in deciding whether

(A) to issue an approval, preliminary certificate or licence or effect a registration, or

(B) to approve a transfer of an allocation of water under a licence,

in the area of the Province to which the approved water management plan applies, and

(b) may include

(i) the number of households permitted on a parcel of land for the purposes of section 21,

(ii) authorization of the ability to transfer an allocation of water under a licence,

(iii) authorization of the ability to withhold water under section 83, and

(iv) a provision on the maximum amount of water that may be diverted under a registration.

(4) The *Regulations Act* does not apply to an approval of a water management plan under this section or to an amendment of an approved water management plan or its cancellation under section 12.

F. Household purposes

21(1) Subject to subsection (3) and section 23 and any exemptions specified in the regulations, a person who owns or occupies land that adjoins a river, stream, lake, natural watercourse or other natural water body

(a) has the right to commence and continue the diversion of the water that adjoins that land for household purposes, whether or not that water is reserved under section 35, and

(b) may not obtain a licence for the diversion of water that adjoins that land for household purposes.

(2) Subject to subsection (3) and section 23 and any exemptions specified in the regulations, a person who owns or occupies land under which groundwater exists

(a) has the right to commence and continue the diversion of the groundwater for household purposes, and

(b) may not obtain a licence for the diversion of the groundwater for household purposes.

(3) The number of households on a parcel of land for the purposes of this section is limited to

(a) the number permitted under an applicable approved water management plan, or

(b) if there is no applicable approved water management plan, the number permitted by an order of the Minister.

(4) A person who diverts water under subsection (1) or (2) may, without an approval, licence or registration, pump or otherwise convey water to the point of use for household purposes.

G. *Riparian owner or occupant*

22(1) Notwithstanding the common law, a riparian owner, riparian occupant or person who owns or occupies land under which groundwater exists has the right to divert water only in accordance with section 21 and may not divert water for any other purpose unless authorized by this Act or under an approval, licence or registration.

(2) A person described in subsection (1) may commence an action with respect to a diversion of water only in respect of a diversion of water that is not authorized by this Act or under an approval, licence or registration.

(3) Nothing in this Act is to be construed so as to repeal, remove or reduce any rights held at common law by a riparian owner or occupant of land or by a person who owns or occupies land under which groundwater exists, other than the right to the continued flow or diversion of water.

H. *Household diversions*

23(1) If the Director is of the opinion that there is or may be a significant adverse effect on the aquatic environment or on a licensee or traditional agriculture user resulting from a diversion of water pursuant to section 21, the Director may, subject to the regulations,

(a) issue a water management order under section 97, and

(b) declare that a person described in section 21 who did not divert water as described in section 21 prior to the date of the declaration may not, as of the date of the declaration, divert water as described in section 21 from a source of water specified in the declaration or from any sources of water within the water management area specified in the declaration.

(2) The Director must provide notice of a declaration in a form and manner satisfactory to the Director.

(3) If, after this Act comes into force, a subdivision of land of a type or class of subdivision specified in the regulations is approved under *the Municipal Government Act*, a person residing within that subdivision on a parcel of land that adjoins or is above a source of water described in section 21 has the right to commence and continue the diversion of water under section 21 only if

(a) a report certified by a professional engineer, professional geologist or professional geophysicist, as defined in the *Engineering, Geological and Geophysical Professions Act*, was submitted to the subdivision authority as part of the application for the subdivision under the *Municipal Government Act*, and the report states that the diversion of 1250 cubic metres of water per year for household purposes under section 21 for each of the households within the subdivision will not interfere with any household users, licensees or traditional agriculture users who exist when the subdivision is approved, and

(b) the diversion of water for each of the households within the subdivision under section 21 is not inconsistent with an applicable approved water management plan.

(4) Notwithstanding subsection (3), a person residing within a subdivision as described in subsection (3) has the right to commence and continue the diversion of water under section 21 if

(a) the written consent of the subdivision authority is provided to the Director,

(b) the Director is of the opinion that there are or were extenuating circumstances with respect to the submission of the report under subsection (3), and

(c) the Director has approved in writing the right to divert under section 21.

I. Traditional agriculture user

24(1) A person who owns or occupies land

(a) to which a registration is appurtenant, and

(b) that adjoins a river, stream, lake, natural water course or other natural water body, or under which groundwater exists,

has the right to commence and continue the diversion of water from the sources authorized in the registration for the purposes of raising animals or applying pesticides to crops, as part of a farm unit, as authorized by the registration.

(2) A person who diverts water in accordance with subsection (1) may, without an approval or licence, pump or otherwise convey water to the point of use on the land that adjoins the source of water, or to an adjacent parcel of land owned by that person if both parcels form part of the same farm unit.

J. Priority of household user – Division 2 Priority of Rights

27 A person who diverts water pursuant to section 21

(a) does not have priority with respect to another person who is diverting water pursuant to section 21, but

(b) has priority over a person who is entitled to divert water

(i) pursuant to an approval, licence or registration, or

(ii) that is authorized under this Act other than pursuant to section 21.

K. Flood risk areas

96(1) If the Minister is of the opinion that there is or may be a risk to human life or property as a result of flooding, the Minister may designate, subject to the regulations,

(a) any area of land in the Province as a flood risk area, either generally or on an interim basis, and

(b) specify any acceptable land uses with respect to the flood risk area.

(2) If the Minister has made a designation under subsection (1)(a), subject to the regulations,

(a) new Government works or undertakings must not be located or carried out,

(b) Government financial assistance must not be given to any person who engages in a use other than a use specified under subsection (1)(b), and

(c) money and services and Government disaster assistance programs may be restricted with respect to flood damage, in the designated flood risk area after the designation has been made, except as specified in the designation or the regulations.

(3) The Minister must consult with the local authority that is responsible for a proposed flood risk area before making a designation under subsection (1).

(4) For the purposes of subsection (3), "local authority" does not include a local authority as defined in section 1(1)(ff)(vi) to (ix).

L. Water management areas

164 The Director may establish water management areas for the purposes of,

(a) administering priority to divert water,

(b) groundwater management,

(c) temporarily assigning water under section 33,

(d) directing that the diversion of water for household purposes cease,

(e) directing that applications for licences are not to be accepted, and

(f) any other matter specified in the regulations.

Appendix E - Glossary

Alluvial Fan

An alluvial fan is a fan shaped feature sometimes formed where a tributary valley enters a main mountain valley. Fans are frequently targeted for development due to their moderate slopes. However, they are very susceptible to flash flooding and channel shifting.

Anthropogenic

Anthropogenic refers to something caused or produced by humans.

Aquifer

An aquifer is an underground water-bearing formation that is capable of yielding water.

Cemetery

Cemetery means land that is set apart or used as a place for the burial of dead human bodies or other human remains or in which dead human bodies or other human remains are buried; (Definition 1(b), *Cemeteries Act*)

Columbarium

Columbarium means a structure designed for storing the ashes of dead human bodies or other human remains that have been cremated; (Definition 1(c), *Cemeteries Act*)

Conversions: Metric to Imperial

1 metre =	3.280839895 feet
100 metres =	~ 325 feet
300 metres =	~ 1,000 feet
450 metres =	~ 1,500 feet
500 metres =	~ 1,640 feet
800 metres =	~ 0.5 miles
1.5 kilometres =	~ 0.9 miles
1.609344 kilometres =	1 mile
0.40 hectares =	~ 1 acre
1 hectare =	2.471054 acres
64.750 hectares =	160 acres

Crematory

Crematory means a building fitted with proper appliances for the purpose of incineration or cremation of dead human bodies, and includes everything incidental or ancillary thereto; (Definition 1(d), *Cemeteries Act*)

Environment

Environment means the components of the earth and includes (Definition t, *Environmental Protection and Enhancement Act*):

(i) air, land and water,

(ii) all layers of the atmosphere,

(iii) all organic and inorganic matter and living organisms, and

(iv) the interacting natural systems that include components referred to in subclauses (i) to (iii).

Eolian

Eolian applies to the erosive action of the wind, and to deposits that are due to the transporting action of the wind.

Escarpment

Escarpment means a steep slope terminating high lands abruptly.

Food Establishment

Food Establishment means a place, premises, or vehicle where, in, on or from which food that is intended for consumption by the public is sold, offered for sale, supplied, distributed, displayed, manufactured, prepared, preserved, processed, packaged, served, stored, transported or handled, and includes a secondary meat processing plant; (definition 1.0(g) of the *Food Regulation 240/85, Public Health Act*)

Hazard Area – refer to Appendix F - Environmentally Significant Areas

Hectares – refer to Conversions: Metric to Imperial

HSQL – refer to Public Health, Safety or Quality of Life Concerns (Public HSQL)

Human Oriented Development (HOD)

Human Oriented Development includes commercial, food establishment, institutional, recreational or residential development.

Industrial Runoff Control Facility

Industrial runoff control facility means any facility that is part of an industrial plant and is designed to collect, store or treat industrial runoff from the plant; (refer to section 1(1)(d) of the *Industrial Plants Regulation (121/93), Environmental Protection and Enhancement Act*)

Industrial Wastewater Control Facility

Industrial wastewater control facility means any facility that is part of an industrial plant and is used for the physical, chemical, biological, radiological or other treatment of industrial wastewater or for the storage, distribution or collection of industrial wastewater from the industrial plant (refer to section 1(1)(f) of the *Industrial Plants Regulation (121/93), Environmental Protection and Enhancement Act*).

Lake Perimeter Trail

A Lake Perimeter Trail consists of a narrow footpath encircling a lake whose route would be carefully chosen to take advantage of scenic viewpoints of the lake and other points of interest, while avoiding natural hazards.

Lakeshore Recreation Area

A Lakeshore Recreation Area is situated within an environmental buffer adjacent to a lake. Specifically, it is located next to the Shore Zone (Appendix F – Lake Zones). The recreation area consists of a roughly semicircular, open area that has a high recreational potential and low habitat ranking. Each recreation area has a fire pit, picnic tables, dock, etc. To ensure that the area does not unduly interfere with buffer wildlife, contamination mitigation and aesthetic functions, its maximum depth (dimension perpendicular to the Shore Zone) is 10 metres, and its maximum width (dimension measured parallel to the Shore Zone) is 20 metres.

Mausoleum

Mausoleum means a structure wholly or partly above the level of the ground and designed for the burial or storage of dead human bodies; (Definition 1(g), *Cemeteries Act*)

Mine

Mine means any opening in, excavation in or working of the surface or subsurface for the purpose of working, recovering, opening up or proving coal, a coal bearing substance, oil sands or an oil sands bearing substance, and includes any associated infrastructure (Definition kk, *Environmental Protection and Enhancement Act*).

New Development

New development means new buildings or other structures.

Non Operating

Non Operating means a development is no longer operational and has either been mothballed, decommissioned, reclaimed, abandoned, or some combination.

Oil Field Waste Management Facility

An Oil Field Waste Management Facility may include building, disposal well, landfill, land treatment and incinerator components. Wastes associated with these facilities may be corrosive, flammable and/or toxic. An approval is required from the Alberta Energy and Utilities Board (AEUB) to construct this facility.

The document entitled *AEUB Oilfield Waste Management Requirements* is available upon request from AEUB Information Services Department (Calgary, 297-8190).

Pipeline

Pipeline means (Definition vv, *Environmental Protection and Enhancement Act*)

(i) a pipe for the transmission of any substance and installations in connection with that pipe,

(ii) a sewer or sewage system and installations in connection with that sewer or sewage system, or

(iii) an underground pipe that contains telecommunication lines.

Pit

Pit means an excavation in the surface made for the purpose of removing, opening up or proving sand, gravel, clay, marl, peat or any other substance, and includes any associated infrastructure, but does not include a mine or quarry (Definition ww, *Environmental Protection and Enhancement Act*).

Potable Water

Potable Water means water that is supplied by a waterworks system and is used for drinking, cooking, bathing, dish washing or other domestic purposes (Definition yy, *Environmental Protection and Enhancement Act*).

Proposed Subdivision Area

Proposed Subdivision Area is that portion of the Titled Area that is to be subdivided to produce additional lots, adjust lot boundaries or consolidate existing lots. The Proposed Subdivision Area may either coincide with the Titled Area, or as is the case of a "first parcel out" in a quarter section, be only a part of the quarter.

Public Facility

In general terms, a public facility is a building such as a hospital or school, or a major recreational facility, for example a major campground, that the Alberta Energy and Utilities Board (AEUB) may designate as a public facility based upon the complexity of evacuation

taking into consideration the number and characteristics of the people using the facility, and the frequency and duration of their use.

According to Sections 9(1) of the *Subdivision and Development Regulation, Municipal Government Act* "A subdivision authority must send a copy of a subdivision application and a development authority must send a copy of a development application for a development that results in permanent additional overnight accommodation or public facilities, as defined by the AEUB, to the AEUB if any of the land that is subject to the application is within 1.5 kilometres of a sour gas facility or a lesser distance agreed to, in writing, by the AEUB and the subdivision authority."

Public Health, Safety or Quality of Life Concerns (Public HSQL)

Developments that have Public Health, Safety or Quality of Life Concerns include airports, industrial facilities, intensive livestock operations, oil and gas wells, pipelines, reservoirs, sour gas facilities (well, pipeline, etc.), resource extraction (mines, pits and quarries), fuel storage tanks, waste management facilities and wastewater systems. These developments potentially have one or more of the following problems:

(1) accidents (explosion, fire, smoke, spillage and release of toxic gases)

(2) contamination of air, water or soil

(3) nuisance (dust, foul odour, negative visual impact, noise, traffic)

(4) subsidence

(5) water related (non contamination related adverse changes to water courses, water bodies, water tables, aquifers)

Quarry

Quarry means any opening in, excavation in or working of the surface or subsurface for the purpose of working, recovering, opening up or proving any mineral other than coal, a coal bearing substance, oil sands or an oil sands bearing substance, and includes any associated infrastructure (*Definition bbb, Environmental Protection and Enhancement Act*).

Shore Zone Access Footpath

A Shore Zone Access Footpath connects, by various means, the rear of each Lake Residential Lot to the Shore Zone (Glossary) of the lake. This type of footpath is curvilinear and narrow enough to prevent use by vehicles (hand cleared).

Slope Movement Caution Zone

The Slope Movement Caution Zone encompasses all land that is situated:

- in the upland area lying outside the valley but near the valley crest
- on a valley side including sloping land and any upper level river terraces or slump blocks
- on a low-level river terrace or floodplain near the valley side

The Slope Movement Caution Zone is not a building or lot boundary setback. Instead, it is an area in the vicinity of the Proposed Subdivision Area that could conceivably be adversely affected by valley side slope movements based on knowing only the steepest overall slope angle and associated overall slope height (refer to Appendix F - Valley). A planner, development officer or Alberta Land Surveyor can delineate the caution zone using these two relatively easy to obtain values.

Sodium Adsorption Ratio (SAR)

Based on experience gained in the area of irrigation water quality, it is recommended that the Sodium Adsorption Ratio (SAR) of the household water supply not exceed 8. If the SAR is greater than 8 there is the potential that the permeability of disposal field soils will be reduced causing system failure. The SAR of a water supply may be calculated by using the ionic concentrations (in mg/litre) of sodium (Na), calcium (Ca) and magnesium (Mg) using the equation below:

$$SAR = \frac{Na/23}{\text{Square Root}(((Ca/20)+(Mg/12))/2)}$$

Storm Drainage System

Storm Drainage System means any system for collecting, storing and disposing of storm drainage, and includes (Definition jjj, *Environmental Protection and Enhancement Act*)

(i) the sewers and pumping stations that make up the storm drainage collection system,

(ii) the storm drainage storage, management and treatment facilities that buffer the effects of the peak runoff or improve the quality of the storm water,

(iii) the sewers and pumping stations that transport storm drainage to the location where it is treated or disposed of, and

(iv) the storm drainage outfall structures.

Suitable Development Area of a Serviced Residential Lot

The Suitable Development Area of a serviced residential lot is an area that is environmentally suitable for the construction and sustainable use of a residence, ancillary buildings and a driveway. Specifically, the Suitable Development Area of a serviced residential lot:

(1) is an unfragmented area;

(2) has low water table conditions (Appendix F – Water Table);

(3) is level or has slopes not exceeding a grade of 15% (8.53°) in an upland non valley area;

(4) is level or has slopes not exceeding a grade of 12.3% (7°) in a valley;

(5) can support a connection to a waterworks system that provides the residence with an adequate, long term supply of potable water;

(6) can support a connection to a wastewater system where there is minimal, long term risk that the connection will malfunction and result in the contamination of surface and/or groundwater;

(7) does not contain an Environmentally Significant Area (Appendix F);

(8) presents minimal risk to property, health or safety by natural environmental hazards such as flooding, erosion and slope movement; and

(9) has minimal Public Health, Safety or Quality of Life Concerns (Glossary) associated with nearby non operating, operating or proposed land uses.

Suitable Development Area of an Unserviced Residential Lot

The Suitable Development Area of an unserviced residential lot is an area that is environmentally suitable for the construction and sustainable use of a residence, ancillary buildings, an access road, a privately owned domestic water well and a private sewage disposal system. In this particular case unserviced means the lot is not connected to a municipal or subdivision based wastewater collection system, or has a sewage holding tank that is a component of a municipally operated pumping/hauling sewage collection system.

Specifically, the Suitable Development Area of an unserviced residential lot:

(1) is an unfragmented area;

(2) is at least 0.40 hectares (~1 acre) in size;

- does not include any part of a lot that cannot be developed for non environmental reasons, for example, a lot boundary setback strip required by a municipality
- does not include any portion of an Environmentally Significant Area (Appendix F)
- does not include any part of a lot that will require significant modification such as regrading, filling or draining to satisfy conditions (2) to (5)

(3) has low water table conditions (Appendix F – Water Table);

(4) is level or has slopes not exceeding a grade of 15% (8.53°) in an upland non valley area;

(5) is level or has slopes not exceeding a grade of 12.3% (7°) in a valley;

(6) can have a household water supply system (Appendix F) that provides an adequate supply of potable water during peak periods and over the long term;

(7) can have a private sewage disposal system (Appendix F) in which there is minimal, long term risk that it will malfunction and contaminate surface and/or groundwater;

(8) presents minimal risk to property, health or safety by natural environmental hazards such as flooding, erosion and slope movement; and

(9) has minimal Public Health, Safety or Quality of Life Concerns (Glossary) associated with nearby non operating, operating or proposed land uses.

Titled Area

The Titled Area consists of one or more titles within which the proposed subdivision is to take place.

Toe of Slope – refer to Appendix F - Valley

Trunk Footpath

A Trunk Footpath is situated within an environmental buffer adjacent to a lake and roughly parallels the Shore Zone (Appendix F – Lake Zones). If over time, buffers are consistently required by subdivision authorities, those responsible for the buffers maintain them in a near natural state, and each contains a trunk footpath, the opportunity arises to create a Lake Perimeter Trail (Glossary).

Unserviced Lot

An unserviced lot is one that is not connected to either a waterworks system or a wastewater system.

Waste Management Facility

Waste Management Facility means a facility for the collection, storage, treatment or disposal of waste (Definition rrr, *Environmental Protection and Enhancement Act*).

Wastewater System

Wastewater System means a system for collecting, treating and disposing of wastewater and includes (Definition sss, *Environmental Protection and Enhancement Act*);

(i) sewers and pumping stations that make up a wastewater collection system,

(ii) sewers and pumping stations that transport untreated wastewater from a wastewater collection system to a wastewater treatment plant,

(iii) wastewater treatment plants,

(iv) facilities that provide storage for treated wastewater,

(v) wastewater sludge treatment and disposal facilities,

(vi) sewers that transport treated wastewater from a wastewater treatment plant to the place where it is disposed of, and

(vii) treated wastewater outfall facilities, including the outfall structures to a watercourse or any appurtenances for disposal of treated wastewater to land or to wetlands;

For a subdivision wastewater collection system, the September 1986 booklet entitled *Guidelines for the Design, Approval and Operation of Sewage Lagoon Systems For Small Municipal Developments* is available upon request from the Municipal Water and Wastewater Branch (Edmonton, 415-1860).

Wastewater Treatment Plant

Wastewater treatment plant means any structure or thing used for physical, chemical, biological or radiological treatment of municipal wastewater, and includes wastewater storage facilities and sludge treatment, storage and disposal facilities. (Definition 1(t) of the *Wastewater and Storm Drainage Regulation 119/93* of the *Environmental Protection and Enhancement Act*.). The Act pertains to wastewater treatment plants that discharge wastewater off the site of the development and are designed to generate more than 50 cubic metres of wastewater per day.

Water Resources Related Works

Water Resources Related Works means works for the diversion and use of water; impoundment of water; diversion of water otherwise than impoundment; development in, over, under, on or adjacent to any water; removal or disturbance of the bed; shore or banks of any water, etc.

Further information on Water Resources Relate Works may be found in Appendix F - "Bed, Shore and Bank of a Naturally Occurring Body of Water".

Waterside Recreational Facility

A waterside recreational facility is a facility such as an amusement park, camp, campground, marina, lodge, recreational vehicle park or resort that is bounded by or contained within the bed and shore of a water feature.

Waterworks System

Waterworks System means any system providing potable water to a municipality, municipal development, industrial development, privately owned development or private utility, and includes (Definition xxx, *Environmental Protection and Enhancement Act*)

(i) water wells, surface water intakes or infiltration galleries that constitute the water supply,

(ii) water supply lines,

(iii) on-stream and off-stream water storage facilities,

(iv) water pumphouses,

(v) water treatment plants,

(vi) potable water transmission mains,

(vii) potable water storage facilities,

(viii) potable water pumping facilities; and

(ix) water distribution systems;

For piped water supply systems, the August 1986 booklet entitled *Guidelines for the Design and Approval of Water Supply Systems for Small Municipal Developments* is available upon request from the Municipal Water and Wastewater Branch (Edmonton, 415-1860).

White Area – refer to Appendix F - Green Area and White Area

Appendix F – Background on Selected Environmental Topics

A. *Badlands*

Badlands consist of an intensely dissected natural landscape where vegetation is sparse or absent due to extremely rapid soil erosion and slope retreat. Aridity and the infertility of the soils also discourage plant growth. Badlands are restricted mainly to areas of arid to semi-arid climate in which relatively weak bedrock is horizontally layered.

In Alberta, badlands topography has developed along some of the river valleys within southeastern Alberta. The Red Deer River and many of its tributaries are especially well known for their badlands. Along this river, excellent examples of badlands are found from west of Big Valley downriver to east of Dinosaur Provincial Park. The Milk River is also acclaimed for its badlands. Other noteworthy badlands have also formed along the Lost River in the southeastern corner of the province, and in the Belly River Buttes northeast of Standoff.

B. *Bed, Shore and Bank of a Naturally Occurring Body of Water*

If at least part of a Proposed Subdivision Area is bounded by or is contained within the bed and shore of a river, stream, watercourse, lake or other body of water, then according to the Subdivision and Development Regulation (section 5(3)(e); refer also to Appendix B, Section D.), the subdivision authority must send a copy of this subdivision application to the Deputy Minister of the Minister responsible for the administration of the Public Lands Act. In the case of lands in the White Area, applications should be sent to the:

Public Land Management Branch
Rural Development Division
Agriculture, Food and Rural Development
Rm. 200 J.G. O'Donoghue Building
7000 - 113 St.
Edmonton, AB T6H 5T6 ..... Phone 427-5570

For the Green Area, applications should be referred to a Regional Land Manager:

- Northeast Boreal (Lac La Biche - 623-5240)
- Northern East Slopes (Whitecourt - 778-7165)
- Northwest Boreal (Peace River - 624-6221)
- Southern East Slopes (Rocky Mountain House - 845-8250)

The bed and shore of this water feature may be claimed under Section 3 of the Public Lands Act. This section is entitled "Title to beds and shores, etc".

3(1) Subject to subsection (2) but notwithstanding any other law, the title to the beds and shores of

(a) all permanently and naturally occurring bodies of water, and

(b) all naturally occurring rivers, streams, watercourses and lakes,

is vested in the Crown in right of Alberta and a grant or certificate of title made or issued before or after the commencement of section 3 of the *Public Lands Amendment Act, 1984* does not convey title to those beds or shores.

(2) Section (1) does not operate

(a) to affect a grant referred to in subsection (1) that specifically conveys by express description a bed or shore referred to in subsection (1) or a certificate of title founded on that grant,

(b) to affect the rights of a grantee from the Crown or of a person claiming under him, when those rights have been determined by a court before June 18, 1931, or

(c) to affect the title to land belonging to the Crown in right of Canada.

(3) For the purposes of subsection (1), a river, stream or watercourse does not cease to be naturally occurring by reason only that its water is diverted by human act.

RSA 1980 cP-30 s3; 1984 c34 s3

PART 1, section 17 of the *Surveys Act* deals with the subject of "Natural Boundary." Section 17(2) gives a definition of bank, and section 17(3) provides a definition of bed and shore.

17(1) A surveyor who needs to determine the position of a natural boundary when performing a survey under this Act may do so by any survey method that has the effect of accurately determining its location at the time of survey, relative to the surveyed boundaries of the affected parcel.

17(2) When surveying a natural boundary that is a body of water, the surveyor shall determine the position of the line where the bed and shore of the body of water cease and the line shall be referred to as the bank of the body of water.

17(3) For the purpose of this section, the bed and shore of a body of water shall be the land covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself.

If a person wishes to modify a lakeshore and/or water body, then they must submit to Alberta Environmental Protection an "Application for Lakeshore/Water Body Modification" pursuant to the *Water Resources Act* and the *Public Lands Act*. The types of modifications that must be applied for include among other things aquatic vegetation control, bank stabilization, erosion protection, wetland management, beech construction, and development of a domestic waterline, outfall, permanent boat launch, permanent pier site or reservoir (see also Glossary – *Water Resources Related Works*). This form is available from the nearest Natural Resources Service regional office (a division of Alberta Environmental Protection).

• Bow Region	Calgary office - Phone 297-6582
• Northeast Boreal Region	Edmonton office - Phone 427-5296
• Northern East Slopes	Edmonton office - Phone 427-8283
• Northwest Boreal Region	Peace River office - Phone 624-6237
• Parkland Region	Red Deer office - Phone 340-5310
•	Leduc office - Phone 986-6286
• Prairie Region	Lethbridge office - Phone 381-5995

It should be noted that all licences, authorisations and approvals issued by Alberta Environmental Protection under the *Alberta Environmental Protection and Enhancement Act*, *Water Resources Act* or *Public Lands Act* should not be taken to mean the proponent (applicant) has complied with provisions of the federal *Fisheries Act* and the *Navigable Waters Protection Act*. The *Fisheries Act*, among other things, prohibits the harmful alteration, disruption or destruction of fish habitat and the deposit of harmful materials into fish-bearing waters. With respect to the *Fisheries Act*, proponents should contact:

Habitat Management
Central and Arctic Region,
Fisheries and Oceans
501 University Crescent
Winnipeg, Manitoba R3T 2N6 ..... Phone (204) 984-2505

In regard to the *Navigable Waters Protection Act*, proponents should contact:

Navigation Protection Program
Canadian Coast Guard
Suite #703, 201 North Front Street
Sarnia, Ontario N7T 8B1 ..... Phone (519) 383-1862

C. *Conservation Easement*

A conservation easement is a legal agreement made between a landowner and a second party, such as a qualified conservation group, local municipality or provincial government agency. The agreement contains conditions that will ensure the easement will be used for conservation purposes. The agreement is registered against the land title and applies to future landowners.

All the legislative tools are now in place for the creation of conservation easements in Alberta. On September 1, 1996, Bill 39, the Environmental Protection and Enhancement Amendment Act, 1996, was proclaimed. The Act includes enabling provisions that allow landowners to create conservation easements. Furthermore, the Conservation Easement Registration Regulation (A/R 215/96) provides for registration of conservation easements.

D. Environmentally Significant Areas

Environmentally Significant Areas are identified in Environmentally Significant Areas studies prepared for the Resource Information Branch, Alberta Environmental Protection and local municipalities (now contact Resource Data Division, Alberta Environmental Protection, Edmonton, 422-3476). The characteristics of these areas are illustrated by the criteria for Environmentally Significant Areas set forth in the M.D. of Cypress Environmentally Significant Areas study.

(1) "hazard" lands that are unsafe for development in their natural state such as floodplains and steep and unstable slopes; or that pose severe constraints on types of development such as eolian surficial deposits and permanent wetlands;

(2) areas that perform a vital environmental, ecological or hydrological function such as aquifer recharge;

(3) areas that contain unique geological or physiographic features;

(4) areas that contain significant, rare or endangered plant or animal species;

(5) area that are unique habitats with limited representation in the region or are a small remnant of once large habitats that have virtually disappeared;

(6) areas that contain an unusual diversity of plant and/or animal communities due to a variety of geomorphological features and microclimatic effects;

(7) areas that contain large and relatively undisturbed habitats and provide sheltered habitat for species that are intolerant of human disturbance;

(8) areas that provide an important linking function and permit the movement of wildlife over considerable distances, including migration corridors and migratory stopover points;

(9) areas that are excellent representatives of one or more ecosystems or landscapes that characterize a natural region;

(10) areas with intrinsic appeal due to widespread community interest or the presence of highly valued features or species such as game species or sport fish; and

(11) areas with lengthy histories of scientific research.

E. Green Area and White Area

In general, the White Area coincides with the settled portion of Alberta. For the most part, provincially owned land within this area is managed by the Public Land Management Branch, of Agriculture, Food and Rural Development (Edmonton, 427-5570). Under certain circumstances this provincially owned land is available for disposition (sale or lease). Provincial Parks are administered by Alberta Environmental Protection, and Special Areas are managed by Alberta Municipal Affairs. Provincially owned land in the remainder of the province falls within the Green Area and is administered by the Land and Forest Service for the management of timber (Edmonton, 422-4738). Depending upon the situation, this provincially owned land is available for disposition (sale or lease).

Further information on the Green Area and White Area may be found in Appendix F - "Bed, Shore and Bank of a Naturally Occurring Body of Water".

F. Hills

Hills may be ridge, mound or irregular in shape. In the Alberta prairies, hills were likely formed by one or more glacial processes, or by post glacial land forming processes (wind, water, ice erosion and deposition). Glaciers disappeared from the prairies more than ten thousand years ago leaving a wide variety of deposits and landforms. Hilly glacial landforms include various types of moraine composed of till, and ice-contact fluvial deposits (sediments deposited by running water in association with glacial ice). Fairly common, post glacial, hilly landforms in Alberta are longitudinal and parabolic sand dunes (eolian deposits).

G. Household Water Supply System

A household water supply system is situated within a lot and provides water to a single household within this lot. A household water supply system may be based upon hauled water and a cistern, a surface water supply or a water well. For household systems using surface water or groundwater, section 1(1)(y)) of the Water Act (Appendix D, Section B.) specifies that a household can use up to a maximum of 1250 cubic metres of water per year for "household purposes." These purposes include human consumption, sanitation, fire prevention, and watering animals, gardens, lawns and trees.

Information on hauled water/cistern household water supply system may be obtained within the Nuisance and General Sanitation Regulation, Alberta Regulation 242/85, Public Health Act (refer to Appendix G, Section A. - Queen's Printer Bookstores).

Where it is unfeasible to connect a proposed subdivision to a municipal waterworks system, it is recommended if it is possible that each lot and associated household have its own water well. This water supply option is favoured because it:

(1) is consistent with rural self-sufficiency;

(2) promotes water conservation;

(3) likely will remain the complete responsibility of the individual lot owner and not the municipality;

(4) likely has lower capital, operation and maintenance costs than alternative methods;

(5) likely has the most predictable costs over the long term; and likely is the most energy efficient.

H. Intensive Livestock Facility

Intensive Livestock Facility is defined in the Code of Practice For the Safe and Economic Handling of Animal Manures (refer to definition 2.8.3.). This document was prepared in consultation with the livestock industry by Alberta Agriculture, Food and Rural Development and may be obtained from the Policy Secretariat, Alberta Agriculture, Food and Rural Development (Edmonton, 427-5359).

An Intensive Livestock Facility is a feedlot or covered facility of significant investment or permanence, capable of confining a minimum number of livestock (see Table 1) at a housing density of more than 1 livestock manure unit per 184 square metres (2000 square feet) (approximately 54 cattle per hectare or 22 cattle per acre) for growing or finishing for market. An Intensive Livestock Facility does not include a seasonal feeding site confining livestock from November 1 to May 31, or livestock confined for branding, sorting, herd health management and market delivery with confinement not exceeding 30 consecutive days.

Table 1. Intensive Livestock Operations - Minimum Size

Livestock Type	Threshold #
Beef Feeder (500 - 1200 lb)	300
Dairy (milking)	All
Piggery (sows: farrow - finish)	30
Piggery (sows: farrow - wean)	50
Piggery (feeders only)	300
Veal	100
Horses (PMU)	75
Poultry (broilers)	10,000 square feet (920 cubic metres)
Poultry (breeders)	500
Poultry (layers)	5,000
Poultry (Turkey broilers)	3,000
Sheep (ewes)	650
Other	Discretionary

I. Lake Zones

The Profundal Zone is associated with the deeper, poorly lit part of a lake that does not support rooted photosynthetic plants.

The Littoral Zone is that portion of the lake and its bed that is relatively well lit by the sun and supports rooted photosynthetic plants matters (Appendix F - Bed, Shore and Bank of a Naturally Occurring Body of Water). Generally it is found around the perimeter of the lake and is situated between the Shore Zone and the Profundal Zone. Within the lake, the Littoral Zone sustains the greatest diversity of plants and animals.

The Shore Zone is adjacent to the Littoral Zone and is that part of the lake bed which is exposed when water levels are low. The upper limit of the Shore Zone is called the legal bank. This bank is a line where land ends and the bed and shore of a water body begins. In most cases, the vegetation above the bank is markedly different from the vegetation below it due to the normal, long continued action or presence of surface water along the land at the edge of the lake. The location of the bank isn't affected by occasional periods of drought or flooding. (Appendix F – Bed, Shore and Bank of a Naturally Occurring Body of Water). This bank separates public land (crown owned) from the adjacent land (usually privately owned). Any proposed subdivision that is bounded by, or contains, either wholly or partially, the bed and shore of a lake must be referred to the Deputy Minister of the Minister responsible for administration of the Public Lands Act (refer to above mentioned Glossary item).

The Backshore Zone consists of a shore area that is adjacent to and above the Shore Zone, and is only acted upon by severe storms or during major flood events. For the purposes of these guidelines, the upper limit of the Backshore Zone is equivalent to the 1:100 year flood event elevation plus 0.5 metres freeboard (for information on lake water levels refer to Appendix H, Section D., Item (7)). Depending upon the location, this zone may be extensive or very narrow.

The Escarpment Zone is composed of a steep bank (grade greater than 15%) and a strip of horizontal or more gently sloping land adjacent to the top of bank. On the lake side, the zone is adjacent to either the Shore Zone or Backshore Zone. On the opposite side, it is contiguous with the Upland Zone. The width of the strip adjacent to the top of bank may vary depending upon the bank's height and stability but should be no less than 6 metres.

The Upland Zone is sufficiently elevated above the lake that it is not prone to flooding, wave erosion or ice thrust. This zone may lie adjacent to either the Escarpment Zone, Backshore Zone or Shore Zone.

J. Lake Water Quality

Any shoreline development should be designed with environmental protection in mind. Certain development activities may increase the amount of nutrients (phosphorus and nitrogen) entering the lake from the developed land. For example, removal of native vegetation and disturbance of the land surface will increase the movement of nutrients (phosphorus and nitrogen) from the land to the lake during snowmelt and summer rain storms. Nutrients enhance the growth of algae and shoreline vegetation, and in sufficient quantity, degrade the condition of the lake. Actions to protect lake water quality include:

(1) Control erosion on roads, boat launch areas, cottage lots, trails, environmental reserve:

- Disturbed areas during construction should be mulched and seeded.
- Preserve existing ground features, such as natural depressions that would allow water to puddle and soak in rather than running off.
- Ditches along road allowances should not channel directly to the lake. Flow should be diverted to wooded areas or allowed to disperse.

(2) Install a properly designed sewage disposal system that is located as far as possible from the lake and inflow creeks.

(3) Maintain or plant native vegetation between the cottage and the lake:

- This buffer strip should be a minimum of 30 metres wide.
- Use a winding footpath, not a lawn or road, to get to the lake.

(4) Leave the shoreline in its natural condition:

- Leave existing rocks and plants in place.
- Don't remove the natural aquatic vegetation in the lake – it provides fish habitat and shoreline protection.
- Don't build an artificial beach or use tires or other materials to protect the shoreline.

K. Mountains

In Alberta, development within mountain areas is very limited due to adverse topography. Development is concentrated in flat to moderately sloping areas within or near the valley floors. Although these areas are more amenable to development they are not without hazard or major constraint. There is a risk, however small, for failure of a nearby mountain side or snow avalanches. In particular, developments should not be located on or near dip slopes, which is where the surface of a mountain side dips in the same direction as the underlying beds and is often more or less parallel to them. Mountain rivers are fast flowing and are prone to flash flooding. Alluvial fans, which are

fan shaped features sometimes formed where a tributary valley enters the main mountain valley, are frequently targeted for development due to their moderate slopes. However, fans are very susceptible to flash flooding and channel shifting. Mountain valleys have also been the site of much underground coal mining. Areas that have been undermined are prone to subsidence and therefore, may be unsuitable for surface development.

L. Nitrate Contamination

Nitrogenous compounds are significant components of fertilizers, human and animal wastes (sewage effluent and sludge, manure), and plant residues (e.g. legumes). When these materials are applied to the land they undergo a variety of chemical, physical, and biological reactions including nitrification and denitrification. Because of the relative stability of the nitrate ion, most nitrogenous compounds in the environment tend to be converted to nitrates.

Ammonium normally binds tightly to soil particles and does not leach into groundwater. In nitrification, which takes place in warm, well-aerated soils, specialized bacteria rapidly convert ammonium to nitrite and then to nitrate. Plants readily use nitrate, as they do ammonium; however; unlike ammonium, nitrate is highly soluble in water, does not bind to soil, and migrates readily to the water table when present in excess of the amount utilized by plants as an essential nutrient (leaching). This is because nitrate is negatively charged and it will not bind to negatively charged soil particles. The amount and rate of nitrate movement is difficult to predict accurately because soil properties can differ widely, even within a field. Sandy, coarse textured soils retain less water than do fine-textured soils with a high clay content. Thus, the potential for rapid nitrate movement below the root zone is greater in sandy soils.

In warm, extremely wet soils where little oxygen is present (anaerobic conditions), denitrification can occur. This process, also carried out by bacteria, converts nitrate to nitrogen gas, which is then released to the atmosphere.

The principal sources of nitrate and nitrite for humans are vegetables and cured meats. They supply more than 95% of the nitrate found in typical American diets. Less than 1% is from drinking water if the drinking water comes from typical U.S. water supplies. Nitrate levels in Canadian municipal water supplies are generally less than 5 mg/L. Nitrate levels in well water are often higher than those in surface water supplies. Nitrate in drinking water becomes a significant concern only when people drink from a water supply that is highly contaminated with nitrate.

For a number of reasons, infants less than three months of age are especially prone to nitrate poisoning. The pH of an infant's gastric juice is relatively high, between five and seven, and bacteria that convert nitrate to more toxic nitrite flourish. When this nitrite reaches the blood, it oxidizes the iron of hemoglobin to form methemoglobin, which cannot carry oxygen. Moreover, the formation of methemoglobin is enhanced in infants because they have a special form of hemoglobin which is more susceptible to reaction

with nitrite, and their enzyme system which converts methemoglobin to hemoglobin is not very active. As more hemoglobin is converted to methemoglobin, symptoms of oxygen starvation occur. The scientific name for this is methemoglobinemia, but it is commonly called blue-baby syndrome. If more than half the hemoglobin is converted, death is likely.

The potential for nitrate induced methemoglobinemia may also be affected by general infant health, inherited metabolic differences, and the degree of breast feeding versus feeding with formula mixed with well water. Almost all reported cases of infant methemoglobinemia have occurred when infants have consumed formula made with private well water. Investigations of many cases in the United States, Europe, and elsewhere have consistently shown that methemoglobinemia does not occur when drinking water contains less than 10 mg/L of nitrate (expressed as nitrate-nitrogen; equivalent to 45 mg/L expressed as nitrate) and occurs only rarely if water has no more than 20 mg/L of nitrate (as nitrate-nitrogen).

According to the Guidelines for Canadian Drinking Water Quality, Sixth Edition (1996), the Maximum Acceptable Concentration (MAC) of nitrate is 10 mg/L of nitrate (as nitrate-nitrogen). The Canadian guidelines explain that the MAC was based on effects in the most sensitive subgroup of the population, the infants; however, "it is considered prudent to minimize exposure of the entire population to nitrate owing to suggestive evidence of an association in several populations between gastric cancer and moderate levels of nitrate in drinking water."

Sources of information for the above discussion on nitrate contamination and associated health problems are Nitrates in Groundwater: Sources and Concerns, University of Arkansas, October, 1993; and the Guidelines for Canadian Drinking Water Quality, Sixth Edition (1996), Health Canada.

M. Private Sewage Disposal Systems – Discussion of Common Types

i. Introduction

This section provides a background on commonly used private sewage disposal systems. Chapter 3 of these guidelines gives procedures for the evaluation of water table conditions and soil percolation rate; and therefore, relates directly to the question of what type of system is most suitable for a particular set of site conditions. Chapter 3, Section B.ii. looks at the pros and cons of using various types of systems. Further information on this subject may be found in the most recent edition of the booklet entitled *Private Sewage Disposal Systems Instructions to Installers* published by Alberta Labour.

A private sewage disposal system is a privately owned system for the treatment and disposal of sewage from privately owned developments such as a restaurant or service station, single family residence or duplex. Each system is situated within the property lines of the development it serves. The system may consist of a septic tank and subsurface disposal field, a septic tank and treatment mound, a sewage holding tank whose contents are pumped out and hauled away by tanker truck to an approved place of disposal, or other approved means of disposal. Private sewage disposal systems are regulated pursuant to the *Plumbing Code Regulation*.

ii. Septic Tank and Disposal Field

(1) The Septic Tank

A septic tank is a watertight storage container into which sewage from the residence is discharged and retained for 24 hours or more (refer to Figure F.M.1). Its primary purpose is to allow solids in the sewage to settle out as sludge (faecal material, soil, seeds, fruit skins, etc.) or to float as scum (grease, oily substances, soap curds, and fats). The sludge is digested by anaerobic (living in the absence of free oxygen) bacteria which are present in the body wastes. These intestinal and pathogenic (disease causing) bacteria thrive and multiply in the septic tank environment which is warm, wet, dark and devoid of fresh air, and often reach higher densities in the tank than in the raw sewage.

The septic tank is pumped out on a regular basis (approximately once a year on average) and its contents hauled to an approved place of disposal such as a sewage lagoon.

(2) Effluent Characteristics

The liquid that emerges from the septic tank is termed effluent. It is comparatively free of fats, materials capable of settling and floating solids. The effluent is a mixture of water and other chemical compounds, minute particles of sewage termed suspended solids, and an abundance of intestinal and pathogenic bacteria and viruses.

(3) Disposal Field Characteristics

The effluent flows out of the septic tank via the main effluent sewer line. Branching off from the sewer line are the weeping laterals that typically consist of 10 cm (4 inch) perforated pipe. They are carefully placed in level trenches such that the pipe is underlain by 30 cm (1 foot) or more of gravel and covered over with 30 to 60 cm (1 to 2 feet) of porous soil (Figure F.M.2). The gravel is covered with a thin layer of straw to prevent the backfill soil from filling the air spaces in the gravel.

Figure F.M.1 – Septic Tank and Disposal Field

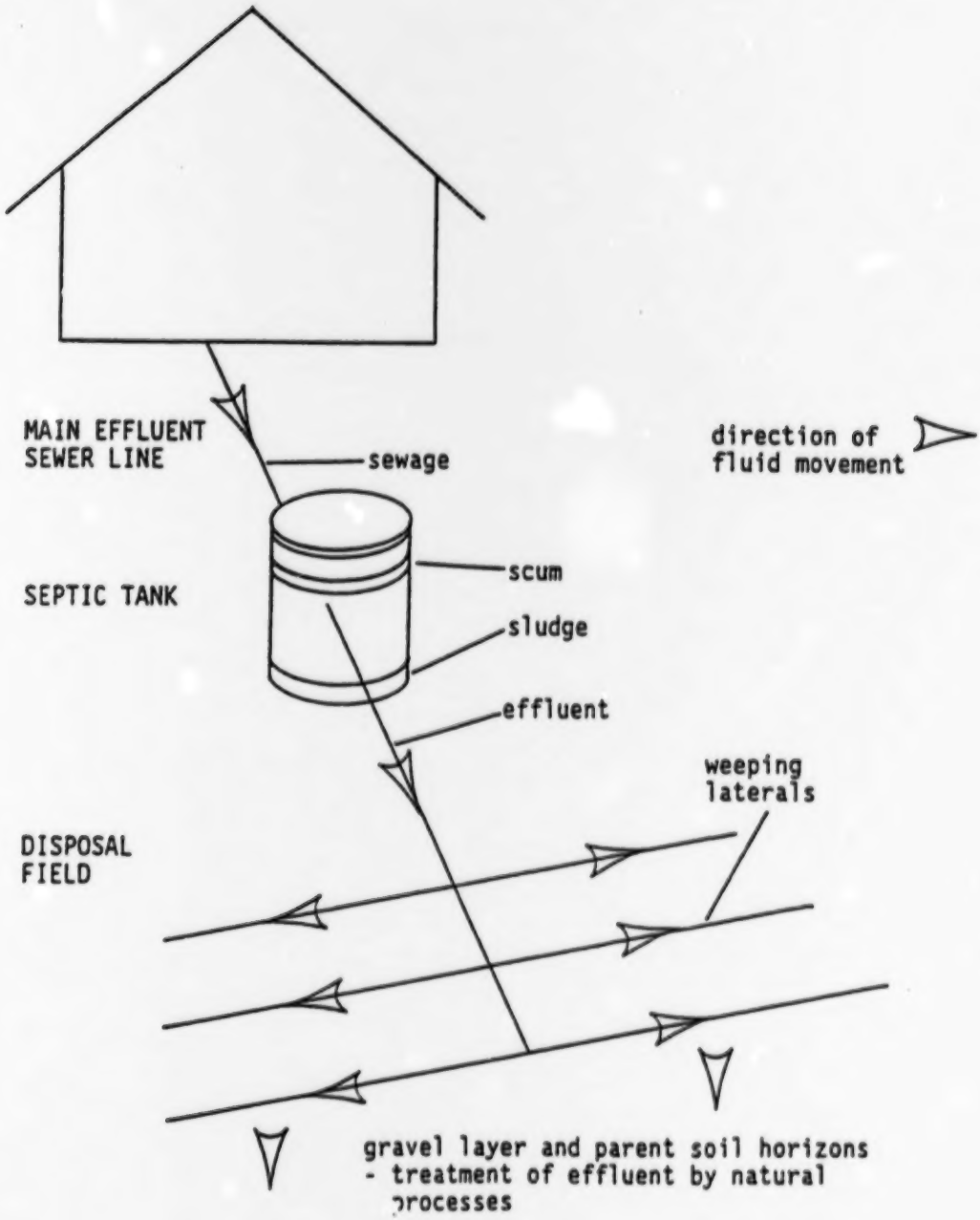
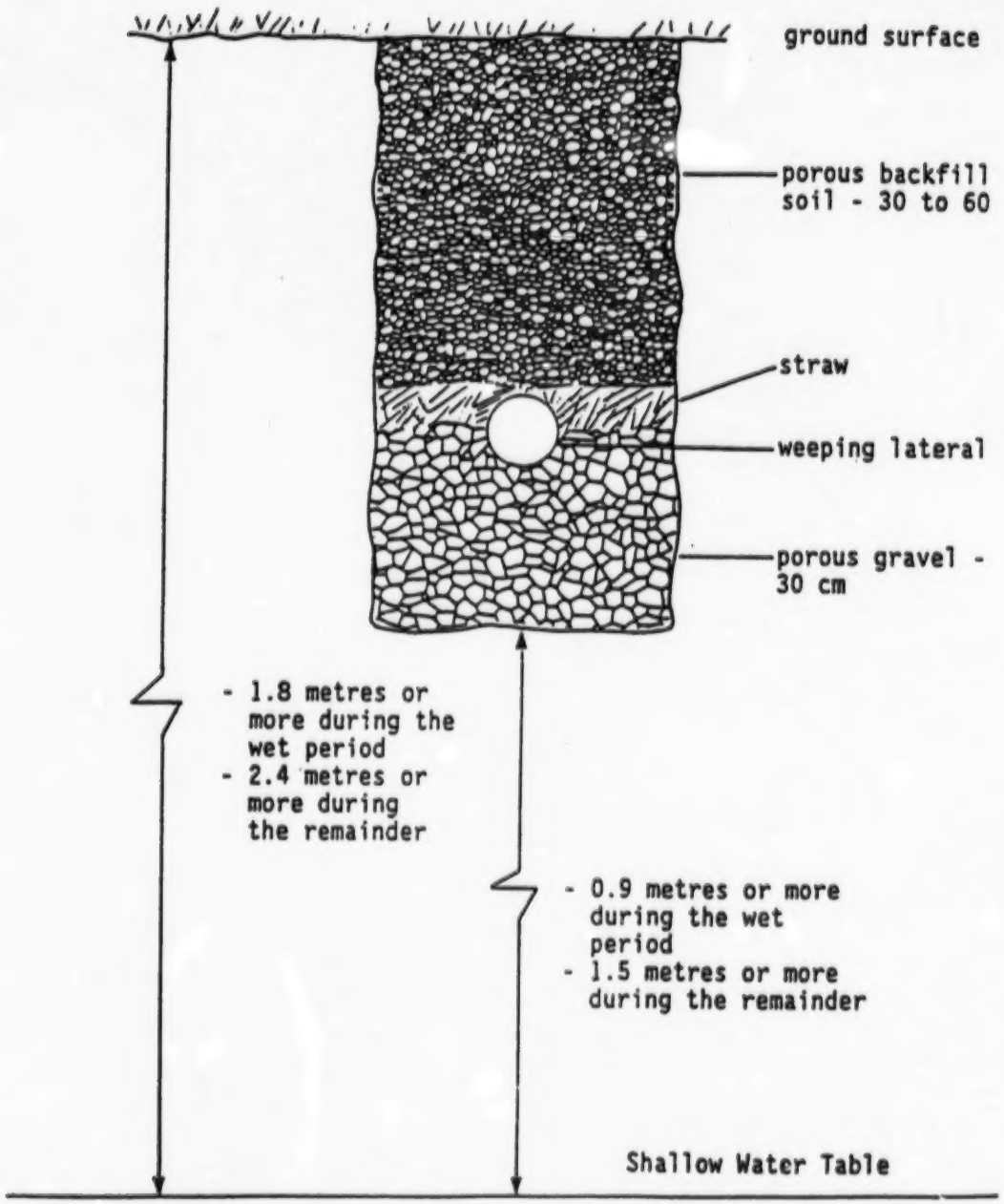


Figure F.M.2 – The Weeping Lateral and its Trench



The total length of the weeping laterals in a disposal field increases with the estimated daily wastewater flow (number of bedrooms) and decreasing soil permeability (soil tightness). The area allocated to the original disposal field and also for its replacement should increase with slope to allow for additional construction difficulties and to take precautions against slides or downhill surfacing of effluent. Ideally the disposal field should be located in a gradually sloping (less than 5%), well-drained, flood free, sunny location where the snow piles deep in the winter and the grass is well kept in the summer.

(4) Development and Function of a Biomat within the Weeping Lateral Trench

As effluent flows into a weeping lateral trench, it moves into the distribution pipe and down through the trench rock to the soil where treatment begins. A biological layer or biomat is formed by soil micro-organisms where they secrete a gluey or sticky substance and anchor themselves to the rock particles and soil. This biomat first forms along the trench bottom, then as liquid begins to pond in the trench, develops along the soil surface of the sidewalls. When fully developed, the gray to black slimy biomat layer is about 1.3 to 2.5 cm (1/2 to 1 inch) thick.

The biomat functions as a valve. Flow through the biomat is considerably slower than through the underlying natural soil. As a consequence, a properly functioning system will have effluent ponded in the trench while the soil immediately outside of and below the trench will be unsaturated. In this situation if proper effluent quality and quantity are maintained the developed biomat is in equilibrium in that it remains at about the same thickness and permeability.

In the equilibrium state two competing processes occur simultaneously at approximately the same rate, thus the thickness and permeability of the biomat remains about the same. On one hand, anaerobic micro-organisms grow and multiply within the biomat and effluent ponded within the trench as they consume organic materials within the effluent. This tends to increase the thickness and decrease the permeability of the biomat. However, on the soil side of the biomat, oxygen is present. In these aerobic conditions soil bacteria feed on and break down the biomat continuously.

A disequilibrium state arises for a couple of reasons. If the septic tank is not pumped regularly the effluent will contain a greater proportion of organic material. In response to this greater food supply the bacterial population grows causing the biomat to thicken and decrease in permeability. Also, if seasonably saturated conditions occur in the soil outside the trench, aerobic conditions will no longer exist, and the biomat will thicken and its permeability will be reduced.

(5) Effluent Treatment beneath the Biomat

Beneath the biomat, unsaturated soil of suitable texture is an excellent treatment medium for effluent. The soil is a self-renewing treatment system and will maintain its treatment effectiveness and capacity as long as the effluent remains of reasonable quality and as long as aerobic conditions exist.

The parent soil horizons underlying weeping laterals form a complex physical, chemical and biological environment through which the effluent infiltrates. Effluent is treated through several natural processes and takes place at both particle surfaces and in the soil solution in contact with air-filled voids.

- Filtration

  Suspended solids, bacteria and viruses are removed by filtration as they pass through the soil.

- Biological Degradation

  Aerobes whose natural habitat is the surface and upper layers of the soil, consume the organic materials (suspended solids, intestinal and disease causing bacteria) within the effluent and break them down into simple and stable compounds. Nitrogen is removed by biological uptake by soil bacteria, and by the biologically mediated processes of nitrification followed by denitrification. In nitrification bacteria oxidize ammonium salts to nitrites, and further oxidize nitrites to nitrates (refer to Nitrate Contamination in this appendix). In the process of denitrification bacteria reduce the nitrates and nitrites usually liberating nitrogen into the air.

- Adsorption

  In the adsorption process dissolved chemical constituents such as nitrogen and phosphorus cling to charged soil particles and become available to plants. This process also removes pathogenic bacteria and viruses from the soil.

- Toxicity and Attrition of Nutrients

  Bacteria and viruses are removed by the action of soil chemicals that are toxic to these organisms, by the accumulated end products of the bacteria themselves and by attrition of nutrients.

The rate at which water can pass through soil is a function of soil permeability. Permeability is affected by the particle size distribution, shape of particles, aggregation of soil particles into larger structural units and

density. Generally, soils consisting mainly of sands and gravels are very permeable, while soils composed predominantly of clay are fine-textured and only slightly permeable (nearly impermeable).

(6) Effluent Treatment Problems beneath the Biomat

Assuming that the naturally occurring water table under a disposal field is low (Glossary; water table), three different problems can develop.

- Very Permeable Soils

  In very permeable soils, problems arise because there is inadequate contact time between the effluent and soils for complete treatment. This may result in the contamination of shallow groundwater aquifers.

- Soil and Bedrock Cracks

  Rapid downward flow of effluent with minimal treatment may occur where there are large cracks in bedrock close to the ground surface, or where channels or cracks develop in fine-textured soils, usually as the result of natural breaks between soil structural units. These channels adjacent to a region of saturation will result in continuous saturated flow through the soil pores.

- Low Permeability Soils

  There is considerable risk that low permeability soils will become saturated with effluent. This results in the elimination of aerobes because oxygen is no longer available. Their disappearance greatly reduces the breakdown of effluent. As well, the suspended solids accumulate rapidly within the soil pores, thus further reducing soil permeability. The end result is that the soil becomes sour (acid in reaction) and septic (anaerobic bacteria and fungi split proteins forming foul-smelling incompletely oxidized products), effluent backs up and spills over the ground surface, and a danger to health arises.

  Disposal fields do not operate properly in areas that have naturally occurring high water table conditions due to the absence of aerobes and deactivation of other treatment processes, and backing up problems. In this case ground and surface water may become contaminated.

  Generally, soils that have low water table conditions and moderate permeability provide the necessary resources for the adequate, long term treatment of effluent by a disposal field. In this case the biomat impedes the flow of effluent into the underlying soil, ensuring that it remains unsaturated and aerobic. The reduced flow rate allows the

effluent to be in contact with the soil a considerable length of time and thus maximizes treatment efficiency.

iii. Septic Tank and Treatment Mound

The treatment mound method is similar to the subsurface disposal field method, the primary difference being that the disposal field is above ground. Treatment mounds are used where the soil is impervious and/or the water table is within 1.52 metres (5 feet) of the ground surface.

The treatment mound is commonly rectangular in shape and has maximum side slopes of 25% (4 to 1 or 14.0 degrees). Preferably it is constructed on level ground. Prior to mound construction the underlying soil is scarified or broken up. Upon this disturbed soil is placed a layer of clean sand that is at least 0.3 metres (1 foot) thick. The next layer, which is less than 0.3 metres thick, consists of gravel ranging in size from 3.8 to 6.4 cm (1.5 inches to 2.5 inches). Within this layer is placed the distribution pipes. This rock layer is covered over with a layer of straw or hay to prevent soil backfill from migrating downwards and filling void spaces. A loam sand cap is placed over the straw or hay and finally the complete mound area is topped with a 15 cm. (6 inch) layer of top soil which is seeded to grass. Effluent is distributed into the underlying filter material via the perforated distribution pipes either under pressure or by gravity. For the most part treatment of the effluent takes place within the mound. Eventually the effluent seeps into the underlying soil where treatment is completed.

Mounds are not suitable where percolation rates are fast since nitrates within the partially treated effluent seeping from the mound are not completely eliminated within sandy soils and thus may contaminate the groundwater.

Depending upon the availability of suitably sized gravel the mound may be very costly to construct.

iv. Sewage Holding Tank

Sewage holding tanks are made of concrete, fiberglass or polyethylene and come in a wide range of shapes and capacities. Sewage from the residence drains through a line to the tank inlet situated somewhere between the top and the 3/4 full mark. Generally the tank is placed in a hole 3.7 to 4.3 metres (12 to 14 feet) deep with the top being below the footings of the residence. It is covered over with 1.8 to 2.1 metres (6 or 7 feet) of earth. The sewage in the tank will likely not freeze primarily because it is below the frost level. For a typical residence a tank is pumped out 2 or 3 times per month and the sewage hauled by a tanker truck to an approved place of disposal. Usually a truck can only haul the contents of one tank at a time.

N. River Flooding and Erosion

i. Introduction

The objective of this section is to provide a background on river flooding and erosion to subdivision approving authorities, municipalities, developers and private lot owners.

ii. Drainage of the Land Surface by Drainage Networks

Precipitation falls to the earth's surface as rain, sleet, hail and snow. Some of this water returns to the atmosphere by evapotranspiration (evaporation plus transpiration from plants), some seeps deep into the ground to become groundwater, and the remainder runs over the surface or through the upper soil horizons. This water tends to collect in channels to form water courses (rills, brooks, creeks, streams, rivers, waterways, etc.). From the air it is evident that channels generally connect to one another in a treelike manner creating a drainage network (refer to Figure F.N.1 showing drainage networks in Alberta). Water flows from the outermost branches of the network towards the innermost, finally entering the main stem channel. Tributaries are channels that contribute water to the stem channel.

Considering drainage networks at the continental level, the stem channel is the channel that enters the ocean. In practice, the continent level network is divided into progressively smaller parts or subnetworks, each being assigned its own name. For example, in Alberta, the Athabasca and Peace Rivers are tributaries of the Mackenzie River network that empties into the Arctic Ocean (refer to Figures F.N.2 and F.N.3). The Athabasca River has many named tributaries including the McLeod, Pembina and Clearwater Rivers and so on.

A drainage basin consists of a drainage network and the land area it drains. The basin may contain one or more water bodies of varying size and shape that may be connected into the network. The water bodies may occupy depressions, for example sloughs, ponds, lakes, etc. Otherwise, they are formed by obstructing stream flow, for instance beaver ponds and reservoirs.

iii. The Discharge Hydrograph and Variations in Discharge

Discharge is a measure of the amount of water flowing though a channel cross-section per unit time and is expressed in cubic metres per second (m^3/s) or cubic feet per second (cfs). Generally discharge fluctuates markedly over time at every point within the drainage network. Discharge can be plotted as a function of time forming a discharge hydrograph. Examination of a station's hydrograph will likely reveal an irregular saw-toothed pattern. Each "tooth" or storm hydrograph charts the rapid rise and gradual fall of discharge in response to either snow melt or rainfall in the basin, or some combination (refer to Figure F.N.4). The size and

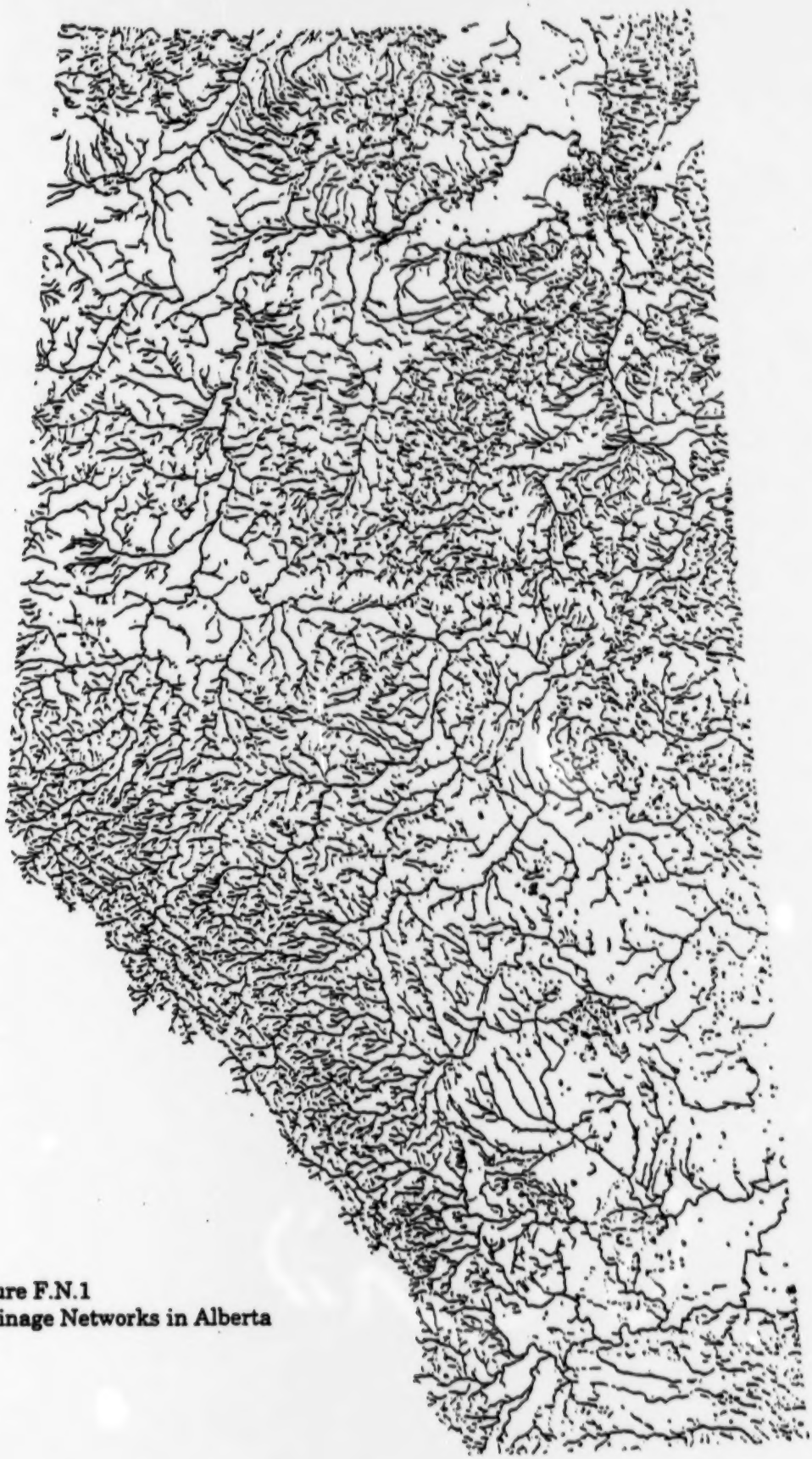


Figure F.N.1
Drainage Networks in Alberta

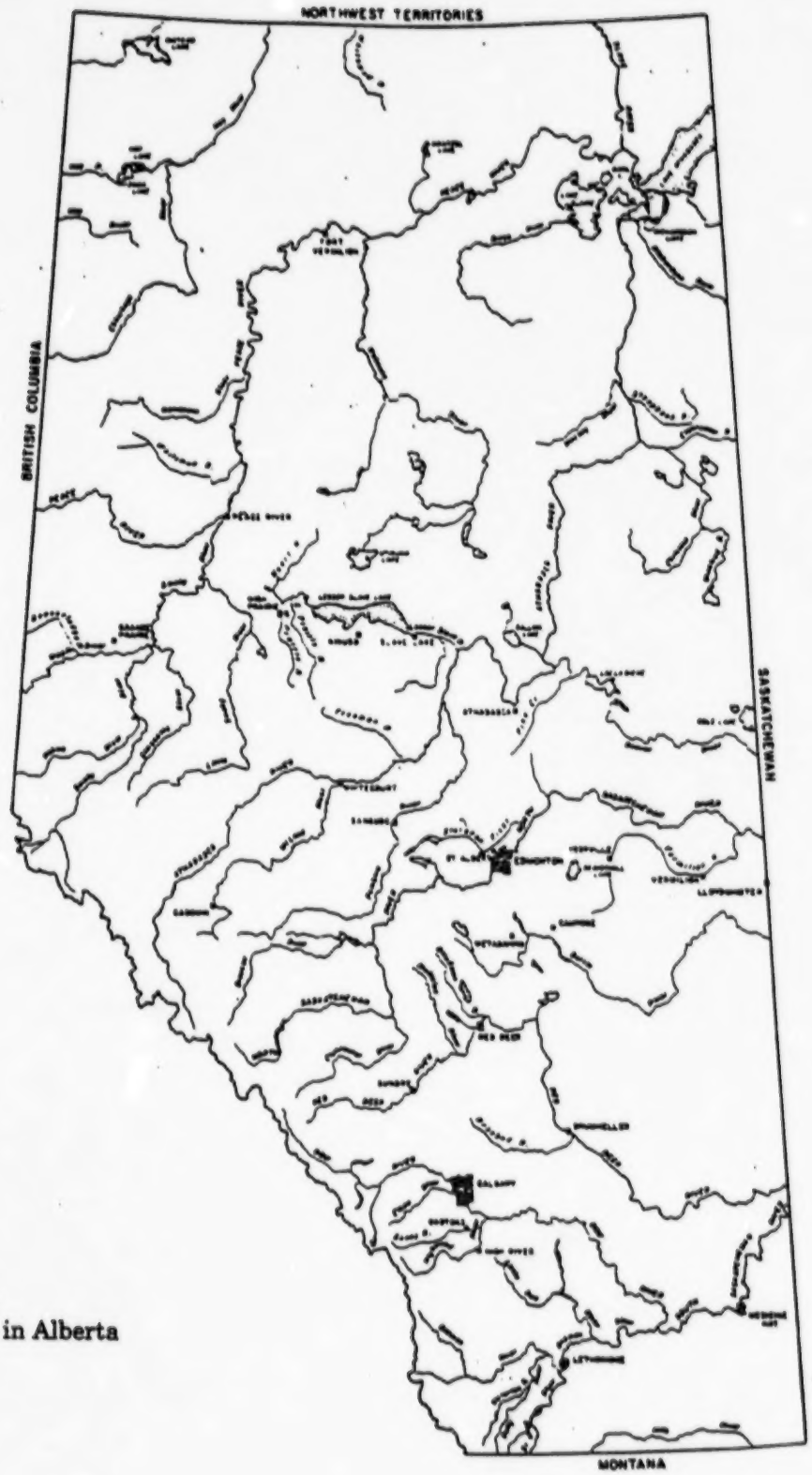
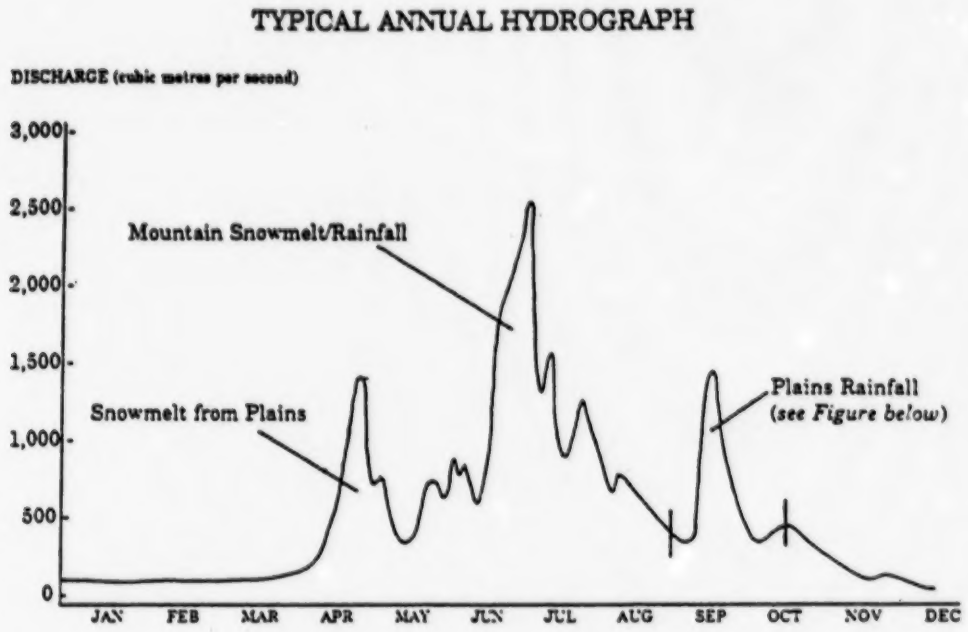


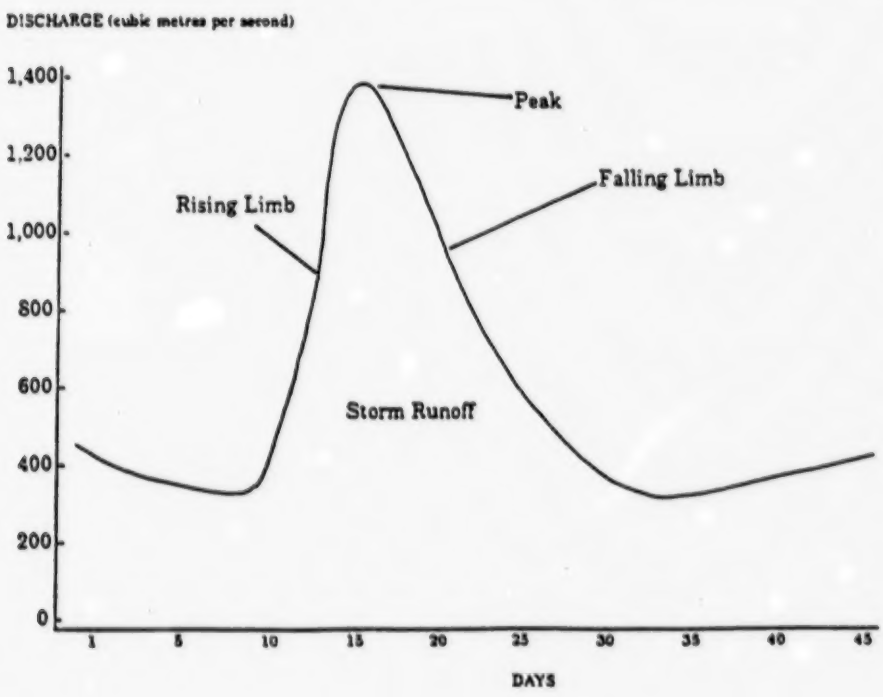
Figure F.N.2
Major Rivers in Alberta

Figure F.N.3

DRAINAGE BASINS

Figure F.N.4 – Example of an Annual Flood Hydrograph
Athabasca River at the Town of Athabasca





shape of the flood hydrograph depend upon a set of interrelated factors including the precipitation, basin, network and channel characteristics, and antecedent conditions. These conditions include basin soil and bedrock moisture storage capacity, and stream flow conditions immediately preceding the onset of the storm.

Channels within the drainage network are differentiated into three types, ephemeral, intermittent and perennial based upon flow conditions between flood events. Ephemeral and intermittent channels typically are the outer branches of the network and are dry for much of the year. Ephemeral channels convey water only during and immediately after an intense rainstorm. Water flows in intermittent channels only during the wet season when the water table is closest to the surface. Perennial channels convey water throughout the year. Between flood events the discharge is low and relatively uniform. This low discharge is called base flow and is maintained by groundwater discharge.

In Alberta, stream flow discharges vary with the seasons. The relative contribution from three sources; rainfall, mountain snowmelt and prairie snowmelt depends upon time and location. Discharge is often elevated during spring prairie snowmelt which can occur between late February in the south to early May in the north. Another discharge pulse occurs in June and July due to summer rainstorms. In some water courses the June flow is further augmented by meltwater from the mountain snowpack (refer to Figure F.N.4 for example).

iv. Affect of Reservoirs, Lakes and Ice Jams on Flow Conditions

Alberta has numerous reservoirs operated for a variety of purposes. Flood abatement reservoirs, for example the reservoir created by the Paddle River Dam, are kept drawn down to very low levels in readiness to receive and store large volumes of flood waters. During the flood event, discharge from the reservoir remains at a high level but below the elevation that would cause significant downstream flooding and erosion. The other types of reservoirs used for irrigation and municipal water supply, hydroelectric power generation, recreation and flow augmentation are operated differently. They retain most of the spring flood waters and may be full most of the time. They have some flood control benefit downstream but this is incidental to their operation.

Lakes are similar to reservoirs. They regulate and reduce flood discharges downstream.

Ice jams temporarily obstruct the channel thereby increasing river depth. Ice jams typically occur either in early winter during river ice formation or in the spring as the ice breaks up.

v. Concept of Flood Frequency and the 1 in 100 Year Flood Event

Inspection of a discharge hydrograph spanning many years will reveal that very high discharges are rare or of low frequency, and relatively low discharges are

common and thus have a high frequency. Furthermore, floods of various magnitudes and frequencies do not occur periodically but randomly and therefore the magnitude and timing of future flood events cannot be accurately predicted. Nevertheless, discharge data can be analyzed to estimate discharges of specified recurrence intervals and the probability of future occurrence. For example, the 1 in 100 year flood is one that has a one percent chance of being equalled or exceeded in any year, or on average would occur once every 100 years. In any given 100 year period, there is a 63 percent chance that the 1 in 100 year flood would be equalled or exceeded at least once.

vi. The Floodplain Concept

Review of historical streamflow data reveals that a typical river will just overtop its banks every few years. This is known as the bankfull discharge. Less frequent flood events with higher discharges and greater flow depths will spill out over low relief areas of the valley floor next to the river. The flow depth and area inundated increases with progressively greater discharges. This area that is subject to infrequent inundation is known as the floodplain. During a flood event, river sediments such as sand and silt are usually deposited on the floodplain. Flooding may accelerate bank erosion and collapse, or the formation of completely new channels.

vii. Erosion

Lateral bank erosion rates are often high in the vicinity of meander scars and high water channels, and for streams that are braided, have a high sinuosity and/or have numerous islands. Estimates of erosion rates may be obtained by comparing air photos taken over a number of years. For a proposed subdivision or development, the erosion hazard can be avoided or mitigated by establishing a buffer and/or instituting some form of bank erosion protection.

viii. Disadvantages of Developing in Areas Prone to River Flooding and/or Erosion

River flooding and erosion pose a major hazard to development. The land, buildings, possessions, road access and even life itself are threatened. Flood waters damage land through erosion, sedimentation (siltation) and subsidence (bank collapse). Buildings and possessions are destroyed by saturation, collapse and transport. Access to a flood stricken parcel may be cut off for days by high flows. Flooding is unpredictable and may be catastrophic. Remedies for flooding such as dams, dykes, channel modifications and floodproofing of individual structures are expensive and not foolproof. Costs for replacement of damaged property can be enormous and may impact not only the individual, but also the government and insurance companies.

ix. Current Streamflow Information

Alberta Environmental Protection's Water Sciences Branch, Forecasting Section, issues current streamflow condition reports, water supply forecasts, high water advisories and flood warnings. Information can be obtained from an automated telephone information/fax on demand service at (403) 207-2718. Please call the Alberta Government RITE Operator at 310-0000 for toll-free access to this service. Alternatively, this information may be found on the Internet at the following address: http://www.gov.ab.ca/~env/water/flood.html.

O. *Slope Movements within Valleys of the Interior Plains of Alberta*

i. Introduction

The objective of this section is to provide a background on valley side slope movements occurring within the Interior Plains of Alberta. Slope movements include falls, topples, slides, spreads and flows (Cruden and Varnes, 1996). Some of the more common factors, both natural and anthropogenic, contributing to slope movements in Alberta are examined. A more comprehensive "Checklist of Landslide Causes" may be found in Cruden and Varnes (1996). This background should be of interest to a variety of individuals who are involved with subdivision or development of land near or within river valleys.

References for this section may be found in Appendix G, Section E. Relevant Internet references are located in the same appendix in Section K. x. and xi.

ii. Natural Processes (Factors) Contributing to Slope Instability

(1) Toe Erosion of Slopes by Rivers and Streams

Slope instability tends to occur on steeply sloping ground. In Alberta, east of the mountains, steep slopes are generally found only in association with the banks of stream and river valleys (Bolduc et al. 1988). Within the stream and river valleys a major contributor to slope instability is the erosion and undercutting of the toe of slope by a water course. Slopes which no longer experience toe erosion are generally more stable. Typically these slopes abut and rise above river terraces that function as a stabilising toe berm (Ruban and Thomson 1983).

Maximum toe erosion and hence peak landslide activity occurs on the outside of river meanders slightly downstream from their mid-point (Ruban and Thomson 1983; J. Bolduc et al. 1988). Cruden et al. (1988) have also observed that significant lateral river erosion takes place opposite islands. In this situation the river is compressed against the slope.

The presence of lateral river erosion may lead to cyclic landsliding. Thomson and Tiedemann (1982) describe the process whereby a slope prone to lateral river erosion fails depositing debris at its toe. For awhile failure ceases due to this toe protection, however, once the debris has been completely eroded away the river once again attacks the slope causing oversteepening. This eventually leads to further slope failure and repetition of the cycle.

(2) Glacial Rebound

While steep valley banks continue to fail to this day, examination of terraces and valley bank slope failures indicate that the rate of failure was higher in the past. As evidenced by low-level terraces that are approximately 6500 to 8000 years old, there was a period of rapid downcutting of post glacial valleys immediately after deglaciation (Thomson and Morgenstern 1977; Cruden et al. 1988). This resulted in massive landsliding of steep valley sides. Thomson and Morgenstern (1977) observed that about 80% of the landslides in their study area in the southern one third of the province, seemed very old and inactive.

(3) Weak Materials

Depending upon the characteristics of the one or more strata or beds, a slope may be more or less prone to instability. East of the mountains, valleys often cut through bedrock overlain by loose rock material. The bedrock is composed of sandstone, siltstone, mudstone and shale, with minor beds of ironstone, limestone and coal. The overlying loose rock material consists of sand and gravel alluvial deposits, eolian silts and sands, lacustrine silts, sands and clays, unsorted glacial deposits and preglacial sands and gravels.

One of the causes of bedrock related instability is the widespread occurrence in Alberta of pure beds of bentonite or bentonite rich beds. Bentonite is a soft, highly plastic clay formed by the chemical alteration of volcanic ash and is composed essentially of montmorillonite and related clay minerals (Bates and Jackson 1984). Ash within Alberta originated from volcanic activity to the south and west (Thomson and Morgenstern 1977). Bentonite beds with a high montmorillonite clay content are characterized by their low shear strength and high swelling potential in weathered conditions (Bolduc et al. 1988). Shear is a type of deformation resulting from stresses that cause adjacent parts of a body to slide relative to each other in a direction parallel to their plane of contact (Bates and Jackson 1984). These conditions provide a plane of weakness for translational movements (Ruban and Thomson 1983).

Bentonite is not the only cause of bedrock weakness. Thomson and Morgenstern (1977) state that soils rich in clay minerals are the least stable. Marine (ocean or inland body of salt-water) deposits tend to have the highest proportion of clay sized particles whereas deltaic, non-marine the least.

Ruban and Thomson (1983) maintain that valley rebound contributes to decreased shear strength along horizontally bedded rock underlying river valleys. The removal of overburden during post glacial valley development results in the elastic rebound of originally flat lying beds along the base of the valley. There is an upwarping of beds below the valley bottom and in the valley banks towards the valley edge. This is accompanied by a slip between the beds. The slip lowers the shear strength along the bedding planes in the valley banks, leading to a greater tendency for landslide activity.

(4) Naturally Occurring High Groundwater Conditions

High groundwater conditions contribute to slope instability (Ruban and Thomson 1983; Goudie 1985). Ruban and Thomson (1983) list a number of indicators of groundwater discharge that include springs, perennial sloughs, phreatophytic vegetation (plants obtaining water directly from the zone of saturation or through the capillary fringe), salt precipitation and saline soils. Springs generally are observed along valley banks and may be associated with lush vegetation growth.

Bolduc et al. (1988) contend that landslides are frequently triggered by a rise in groundwater, often during spring run-off. When the present-day river occupies or is in the immediate vicinity of a preglacial valley, which is usually floored with clean, free draining sands and gravels, the water table is lowered and consequently, landslide activity is greatly reduced (Bolduc et al. 1988).

(5) Slides - Areas of Self-perpetuating Instability

Ruban and Thomson (1983) observe that a rotational slide may be a site of ongoing instability. After a slide the main scarp at the head of a slide may be almost vertical, and if the main mass has slipped down far enough, is unsupported. They explain that water can enter into tension cracks formed parallel to the crest of the slide and within the slide mass. This results in an increase in porewater pressure. Also, water may pond behind backward tilted blocks within the slide mass resulting in high groundwater table and high porewater pressures. By the successive creation of steep scarps and infiltration of water, these sites become self-perpetuating areas of instability.

iii. Human Factors Contributing to Slope Movements

Development, past and present, on or in close proximity to valley sides frequently contributes to slope instability or indeed triggers slope movements. These landslides are attributed to a number of different mechanisms, two or more of which may be acting together on a given valley bank.

(1) Surface Disturbance - (excavating, filling, regrading)

Excavating, filling and regrading are common practices on or in close proximity to valley banks. The immediate and direct impacts of these activities may include one or more of the following: steepening the bank, overloading on or near the valley crest, disturbing natural surface and subsurface drainage patterns, and destroying natural vegetation and associated root mat which helps to reduce erosion. Indirectly, and as a response to these changes, the local groundwater table may rise and soil strength decrease. If surface disturbance is not conducted with due regard to potential problems the net result will be to destabilize the valley bank.

Excavation of the toe of a slope, for instance by a road cut, results in a steepening of the slope gradient. As is the case with the erosion of the toe of slope by stream action, the risk for slope instability increases.

Placing fill or spoil piles (mounds of excavated or dredged earth or rock) on or near the crest of the slope may have a number of consequences. It increases the overall slope angle and overloads the slope thus causing slope instability (Thomson and Tiedemann 1982). Ruban and Thomson (1983) describe how in Lethbridge, fill was placed along the crest of a coulee to extend the backyards of homeowners. This action blocked natural subsurface drainage and caused a rise in the local groundwater table. The soil porewater pressures were further increased by lawn watering, with the end result being major slope failure. This example illustrates how a combination of anthropogenic mechanisms, filling and lawn watering can initiate slope failure.

(2) Water Diversion

Water is a major cause of slope instability. Water spilling over a valley bank saturates it and may cause severe erosion in the form of gullying. Water infiltrating (seeping) into the soil close to the valley crest or on the slope itself locally elevates the groundwater table causing a rise in soil porewater pressure thus increasing the risk of slope instability.

Uncontrolled urban surface runoff from roofs, paved areas (driveways, roads and parking lots), containment structures (swimming pools, fish ponds, lagoons), ephemeral drainage courses, etc., is sometimes diverted over valley banks or allowed to seep into the ground close to the valley crest. This

uncontrolled snowmelt or stormwater may cause gullying, elevated water table conditions and ultimately slope instability.

Thomson and Tiedemann (1982) describe how urban landscaping and servicing in the vicinity of valley banks may increase the local groundwater table and lead to slope failure. Residential and park landscaping involves the removal of natural vegetation, some regrading of the site and replanting with ornamental trees and lawns. Two problems arise. Firstly, rain and snowmelt characteristics are altered such that more water now seeps into the subsurface. Secondly, this trend is further exacerbated by the augmentation of natural precipitation by lawn and garden watering (by hand or sprinkler systems). In addition, leaky sewer and water lines produce elevated water table conditions. If utilities are in a failure zone these authors explain that initial soil movements that often precede a landslide may fracture the sewer and water lines. The water that escapes may well hasten failure and increase the mobility of the failed mass.

There are identical concerns with surface runoff and landscaping for rural residential subdivisions. With respect to sewage disposal, placement of a disposal field too close to the valley crest will increase local groundwater levels thus decreasing slope stability.

Infiltration of agricultural runoff is also a problem. Ruban and Thomson (1983) observed that excessive field irrigation, construction of water reservoirs along valley crests and seepage from irrigation canals near slopes lead to increasing porewater pressures and decreasing overall slope stability. Similarly, these authors have observed that uncontrolled discharge of excess irrigation water causes valley bank erosion, oversteepening, saturation and finally slope failure.

(3) Mining and Tunnelling

Coal mining modifies the water table, disturbs the slope surface with access roads, buildings, spoil/tipple piles (a tipple is a structure where coal is cleaned and loaded in railroad cars or trucks), excavation, etc., and induces subsidence as cavities collapse. In the Lethbridge area Ruban and Thomson (1983) report that subsidence over coal mines appears to be responsible for several series of major cracks and two slides located along the valley bank. Cracks produced by subsidence generally parallel the crests of coulees in the slide area and in one case a major crack is suspected of forming the backscarp of a slide. Thomson and Tiedemann (1982) have discussed the major role mining has played in evolution of the Grierson Hill slide area in Edmonton. They believe that "mining activity by subsidence and by stress relief, brought about an opening of joints and cracks that allowed ingress of water to depths much greater than was possible under natural conditions. The soil mass was weakened to a major degree hence much more susceptible

to failure when subject to hydrostatic pressures generated by a prolonged rainy period."

According to Thomson and Tiedemann (1982) "tunnelling, similar to mining, has caused instability when the natural stress pattern in a slope is disturbed by tunnel construction."

An initial assessment of the extent of coal mining in a given area may be determined by reviewing the Energy Resources Conservation Board (ERCB) *Coal Mine Atlas - Operating and Abandoned Coal Mines in Alberta ERCB 85-45.* If a proposed development is in the vicinity of an existing or abandoned coal mine, then refer to the *General Guidelines for the Development of Lands in the Vicinity of Coal Hazards in Alberta* to assist in the environmental review of this application. This document, which is still in draft form, may be obtained from the Standards and Guidelines Branch, Alberta Environmental Protection (Edmonton, 427-8475).

iv. Lot Boundary Setbacks

There will continue to be ongoing pressure to subdivide land on or near valley slopes. Subdivision at the toe of a valley slope, or even on the valley side itself, often is the result of the expansion of an urban centre that originated on a low-level terrace adjacent to the river. High real estate values and scarce available space begin to favour the subdivision of this marginal land. In an urban setting, the motivation to develop along the crest of a valley may be identical to that of the toe and bank areas. In addition, especially for urban and rural residential development, the crest of a valley provides a prized scenic viewpoint and easy access to valley natural areas.

Competing against the economic, aesthetic and recreational reasons to develop on or very near a valley slope are the concerns for maintaining the integrity of the natural environment, and long term protection of the subdivided land, and associated development, from the adverse effects of slope failure. The primary methods for addressing these concerns are setting back lot boundaries from hazard or sensitive areas, and/or setting aside undevelopable land as either Environmental Reserve, Environmental Reserve Easement or a Conservation Easement (Appendix F). Secondarily, certain development restrictions may be placed on a lot.

The determination of an appropriate lot boundary setback distance from the valley side is a complex undertaking, and one for which numerous methodologies, both theoretical and empirical, have been advocated. Both natural and human factors should be taken into account by the geotechnical consultant. The methodology advocated in these guidelines is presented in Chapter 5, Section C. - The Geotechnical Assessment and its Report.

P. Valley

Valleys are sometimes referred to as coulees, canyons, draws, gullies and ravines depending upon their size, shape, evolution and locally preferred name. Valleys are almost always found in association with and formed by water courses and their channels (rills, brooks, creeks, streams, rivers, waterways, etc.). Examination of air photos reveals that channels and their associated valleys generally connect to one another in a treelike manner creating what is termed a drainage network. Water flows from the outermost branches of the network (tributaries) towards the innermost, finally entering the main stem channel. The land area drained by a drainage network is termed the drainage basin. The basin may contain one or more water bodies of varying size and shape that may be connected into the network. The water bodies may occupy depressions, for example sloughs, ponds, lakes, etc.; or they may be situated on a valley floor and formed by the natural or artificial obstruction of stream flow, for instance beaver ponds and reservoirs.

A portion of the valley floor may be floodprone and/or erosion prone. The floodprone area is referred to as a floodplain.

A valley may contain one or more bench (or platform) like features at different elevations that are relatively flat, horizontal or gently inclined. These features may be:

- active floodplains
- river terraces which are abandoned floodplain remnants
- large blocks of material that have moved down slope as a result of the failure of the valley side (landslides, slumps, etc.).

Due to the presence of river terraces and slope movements, grades (slopes) on the valley side may vary considerably if viewed in cross-section. A crest of a valley is the transition line between a land surface below the line where grades exceed 12.3% (7°) and a land surface above the line where grades are less than 12.3%. Conversely, a toe of a valley slope is either where a valley slope with grades exceeding 12.3% enters the river, or the transition line between a land surface above the line where grades exceed 12.3% and a land surface below the line where grades are less than 12.3%.

The valley crest is the dividing line between valley and non-valley lands. Specifically, the valley crest refers to the transition line between the valley side where grades exceed 12.3% and the adjacent upland area where slopes are less than 12.3%.

The valley side at a particular location may contain several river terraces at different elevations. Of this set of river terraces, the terrace with the lowest elevation (least height above the river) is the low-level river terrace. Although there are exceptions, the low-level river terrace is typically more extensive (breadth and length) than its higher level terrace neighbours. This is because it is more youthful, and therefore, the river has had the less time to erode it and reduce its size.

The valley side toe of slope is where the valley slope either:

- enters the river if there is no extensive low-level river terrace or floodplain adjacent to the river channel (commonly encountered on the outer bend of a meander)
- meets an extensive floodplain or low-level river terrace lying adjacent to the river.

The overall slope is an idealized line connecting a point on the valley crest with the closest point on the valley side toe of slope. The overall slope angle, α, is the angle of the overall slope, for example 24.9% or 14.0°. For a selected overall slope, the overall slope height, H, is the difference in elevation between the valley crest point and the valley side toe of slope point.

Within a selected valley side area, the steepest overall slope is the overall slope line with the greatest overall slope angle. The angle of this slope is called the steepest overall slope angle, α_s. If the steepest overall slope angle and associated overall slope height are known, the width of the Slope Movement Caution Zone adjacent to the valley crest or valley side toe of slope can be calculated. The caution zone is not a building or lot boundary setback or setforwards. Instead, it is an area in the vicinity of the Proposed Subdivision Area that could conceivably be adversely affected by valley side slope movements based on knowing only these two factors (refer to Glossary, Slope Movement Caution Zone).

Due to flooding, erosion and slope failure hazards, and major development constraints, valleys frequently have been avoided even in populated areas, and therefore contain remnant natural environments. These natural valley environments function as wildlife corridors and refuges, and sometimes as recreational corridors. However, despite the hazards, constraints and conservation concerns, there will continue to be ongoing pressure to subdivide near or within valleys. Subdivision within flood prone areas, adjacent to the valley side toe of slope, or even on the valley bank itself, often is the result of the expansion of an urban centre that originated on a floodplain or low-level terrace adjacent to the river. High real estate values and scarce available space begin to favour the subdivision of this marginal land. In an urban setting, the motivation to develop along the valley crest may be identical to that of the toe and bank areas. In addition, especially for urban and rural residential development, the valley crest provides a prized scenic viewpoint and easy access to valley natural areas.

Competing against the economic, aesthetic and recreational reasons to develop adjacent to a water feature, within a floodplain, or on or very near a valley side are a variety of counterbalancing concerns. These include the desire to maintain the integrity of the natural environment, prevent contamination of the downstream water courses and water bodies, and protect over the long term the subdivided land, and associated development, from the adverse effects of flooding, erosion and slope movement. The primary methods for addressing these concerns are setting back lot boundaries from hazard or sensitive areas, and/or setting aside undevelopable land as either Environmental Reserve,

Environmental Reserve Easement or a Conservation Easement (Appendix F). Secondarily, certain development restrictions may be placed on a lot.

Q. *Water Table*

The water table is that surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere (Driscoll 1986). The water table can be viewed directly by drilling an observation well into this groundwater body and waiting for the water level to stabilize. Repeated measurement of the water level in this well over a year or so will likely reveal that the water level fluctuates, perhaps by a metre or more. The separation between the water table and ground surface may also vary considerably over small distances as revealed by simultaneous measurement of water levels in neighbouring wells. The water table level in a well is influenced by such factors as weather, season, water levels of nearby water bodies or water courses, groundwater discharge, surficial stratigraphy and topography.

Low water table conditions are present where the water table is 1.8 metres (6 feet) or more below the ground surface during the frost free period up until the end of August, and 2.4 metres (8 feet) or more below the ground surface during the remainder of the year. This definition recognizes that the water table will probably be elevated in the spring due to the infiltration of snowmelt and during the summer rainy season. High water table levels can:

(1) adversely affect the functioning of a sewage disposal system, which could lead to shallow groundwater and/or surface water contamination;

(2) render the area unsuitable for residential basement construction, interfere with the construction of roads, etc.

R. *Working Area of a Wastewater Treatment Plant*

The working area of a wastewater treatment plant includes that portion of a parcel that is currently being used or will be used by an operating wastewater treatment plant. Specifically the working area of a particular plant is composed of one or more of the following:

(1) the high water level surface of the cells forming a wastewater stabilisation pond (lagoon system);

(2) the outside edge of a mechanical wastewater treatment plant building;

(3) the high water level surface of the cells forming an aerated lagoon system associated with a mechanical wastewater treatment plant;

(4) the operating water level surface of process units or open storage components associated with a mechanical wastewater treatment plant;

(5) "area" where a wastewater stabilisation pond is planned;

(6) "area" where a mechanical treatment plant building is planned;

(7) "area" where an aerated lagoon system associated with a mechanical wastewater treatment plant is planned; or

(8) "area" where process units or open storage components associated with a mechanical wastewater treatment plant are planned.

The working area does not include any vacant land within a parcel unless it will be used for an "area" as outlined above nor does it include that portion of a parcel that is currently being used or will be used by:

(1) access roads;

(2) ancillary buildings (e.g. equipment storage);

(3) easements for pipelines into or out of the facility; or

(4) parking lots

Upon receipt of an application the subdivision and development authority must determine whether or not there will be less than 300 metres between the working area of a proposed or existing wastewater treatment plant and any proposed or existing schcol, hospital, food establishment or residence.

Air photos may be scaled to roughly establish the separation distance. If more precise measurements are required, drawings showing as built and future development areas may be available from the plant operator. If the precise location of a proposed school, hospital, food establishment or residence is not known, the subdivision authority must determine whether at least part of the proposed parcel containing a suitable building site is at least 300 metres or more from the working area of the plant.

If the setback distance cannot be met, a request for approval to vary can be submitted to Alberta Environmental Protection by the subdivision or development authority. The authority should be supportive of the proposal, that is, willing to grant approval to an application if the Department waives the standard setback requirement. The request for variance of the 300 metre setback standard should clearly document the situation using both text and map(s). Requests should be sent to the Regional Managers, Environmental Services, Alberta Environmental Protection (private callers within Alberta can phone the Regional Information Telephone Enquiry RITE Number 310-0000 to connect toll free to the following numbers).

- Regional Managers, Approvals, Environmental Services

- Bow Region (Calgary, 297-7948)
- Parkland Region (Red Deer,)
- Northern East Slopes Region (Edson,)
- Northwest Boreal Region (Peace River, 624-6405)
- Northeast Boreal Region (Edmonton, 427-7617)
- Prairie Region (Lethbridge, 381-5512)

Appendix G - References

NOTE: TOLL FREE CONNECTION TO PROVINCIAL GOVERNMENT OFFICES:

For information and assistance in completing calls to provincial government offices, private callers within Alberta can phone toll free the Regional Information Telephone Enquiry RITE Number 310-0000.

A. Acts and Regulations

(1) *Cemetery Act*

(2) *Environmental Protection and Enhancement Act*

Activities Designation Regulation (Alta. Reg. 110/93)
Activities Designation Regulation Amendment (Alta. Reg. 211/96)
Approvals Procedure Regulation (Alta. Reg. 113/93)
Conservation and Reclamation Regulation (Alta. Reg. 115/93)
Industrial Plants Regulation (Alta. Reg. 121/93)
Waste Control Regulation (Alta. Reg. 192/96)
Wastewater And Storm Drainage Regulation (Alta. Reg. 120/93)

(3) *Environmental Protection and Enhancement Amendment Act, 1996 (SA 1996 c17)*

Conservation Easement Registration Regulation (Alta. Reg. 215/96)

(4) *Fisheries Act* (federal)

(5) *Land Titles Act*

(6) *Municipal Government Act*

Land Use Policies (Order in Council 522/96)
Subdivision and Development Regulation (Alta. Reg. 212/95)
Subdivision and Development Amendment Regulation (Alta. Reg. 53/96)

(7) *Oil and Gas Conservation Act*

(8) *Navigable Waters Protection Act* (federal)

(9) *Public Health Act*

Nuisance and General Sanitation Regulation (Alta. Reg. 242/85)

(10) *Public Lands Act*

(11) *Safety Codes Act*

Plumbing Code Regulation (Alta. Reg. 211/92)

(12) *Surveys Act*

(13) *Water Resources Act/Water Act*

(14) *Wildlife Act*

Note: The Queen's Printer Bookstores publish Alberta acts, regulations, the Alberta Gazette and selected departmental publications.

11510 Kingsway Avenue
Edmonton, AB T5G 2Y5 ..... Phone 427-4952
.....Fax 452-0668

Main Floor, McDougall Centre
455 - 6th Street SW
Calgary, AB T2P 4E8 ..... Phone 297-6251
.....Fax 297-8450

The Queen's Printer catalogue, on-line text files of Alberta's laws and regulations, and other materials can be viewed on the Internet.

Internet - ..... [Queen's Printer Bookstore Home Page]
..... http://www.gov.ab.ca/qp/

B. Water Supply

(1) Driscoll, F.G. 1986. *Groundwater and Wells* - Second Edition. Johnson Filtration Systems Inc., St. Paul, Minnesota 55112.

(2) *Guidelines for Canadian Drinking Water Quality*, Health Canada

(3) *Guidelines for the Design and Approval of Water Supply Systems For Small Municipal Developments* (August 1986) available from the Municipal Water and Wastewater Branch (Edmonton, 415-1860)

(4) *Standards and Guidelines for Municipal Water Supply, Wastewater and Storm Drainage Facilities* (March 1988) (currently under review) available from the Municipal Water and Wastewater Branch (Edmonton, 415-1860)

(5) *Water Wells that last for generations* 1998 available from Alberta Agriculture, Food and Rural Development (Edmonton, 427-2181), PFRA - Prairie Farm Rehabilitation Administration (Edmonton, 495-3307), Water Data Management Section, Alberta Environmental Protection (Edmonton, 427-2770)

C. *Sewage Disposal*

(1) Guidelines *for the Design, Approval and Operation of Sewage Lagoon Systems For Small Municipal* Developments (September 1986) (currently under review) available from the Municipal Water and Wastewater Branch (Edmonton, 415-1860)

D. *River Flooding and Erosion*

(1) *Floodproofing Protect your home against flooding* February, 1996. River Engineering Branch, Alberta Environmental Protection (available from the Information Centre - Alberta Environmental Protection, Edmonton, 422-2079)

E. *Slope Movement Hazards*

(1) Bates, R.L., and Jackson, J.A. 1987. *Glossary of Geology* – American Geological Institute, Falls Church, Virginia, U.S.A.

(2) Bolduc, J., Cruden, D., Leung, S., Sonnenberg, R., and Thomson, S. 1988. *Landslide incidence in Alberta south of 54 degrees N.* Alberta Environment, Research Management Division.

(3) Cruden, D.M., and De Lugt, J.S., March 1991. *Setbacks from Slope Crests for Structures.* Innovative Housing Grants Program, Alberta Municipal Affairs, 1991.

(4) Cruden, D.M., Tedder, K.H., and Thomson, S. 1989. *Setbacks from the crests of slopes along the North Saskatchewan River, Alberta.* Canadian Geotechnical Journal, vol. 26, pp. 64-70.

(5) Cruden, D.M. and Varnes, D.J., 1996. *Landslide Types and Processes.* Chapter 3, *SR 247: Landslides: Investigation and Mitigation.* Transportation Research Board, Box 289, Washington, D.C. 20055.

(6) De Lugt, J.S., Thomson, S., Cruden, D.M., 1993. *A suggested method for estimating setbacks from the crests of slopes on the Interior Plains in Alberta.* Canadian Geotechnical Journal, vol. 30, pp. 863-875.

(7) Energy Resources Conservation Board 1985. *ERCB Coal Mine Atlas Operating and Abandoned Coal Mines in Alberta ERCB 85-45.* Energy Resources Conservation Board.

(8) Goudie, A.I., 1985. *The Encyclopaedic dictionary of physical geography.* Basil Blackwell Ltd. Oxford England.

(9) Ruban, A.F., and Thomson, S. 1983. *Slope instability along the Oldman River and tributaries in the vicinity of Lethbridge.* Alberta Environment, Design and Construction Division, Geotechnical Branch.

(10) Thomson, S., and Morgenstern, N.R. 1977. *Factors affecting distribution of landslides along rivers in southern Alberta.* Canadian Geotechnical Journal, 14: 508-523.

(11) Thomson, S., and Tiedemann, C.E. 1982. *A Review of Factors Affecting Landslides in Urban Areas.* Bulletin of the Association of Engineering Geologists Vol. XIX. No. 1. pp. 55-65.

F. Lakes and Reservoirs

(1) *Atlas of Alberta Lakes,* 1990, edited by Patricia Mitchell and Ellie Prepas, Edmonton: University of Alberta Press

(2) *Alberta Lakes and Reservoirs Reference Index,* 1996, available from the Water Sciences Branch, Alberta Environmental Protection (Edmonton, 427-2770)

(3) *Guidelines for Development Adjacent to Alberta Environmental Protection Water Supply Reservoirs* available from the Operations Branch, Water Management Prairie Region (Lethbridge, 381-5300)

(4) *Guidelines for Lakeshore Use,* Publication No. 1/453 (revised 1997). Brochure is a joint publication of Alberta Agriculture, Food and Rural Development and Alberta Environmental Protection.

(5) Moore, L., and Tomorrow M., Fourth Printing 1991. *The Lake Book – Actions You Can Take to Protect Your Lake.* Published by the Congress of Lake Associations (COLA) (Yarmouth, Maine, 846-4271)

(6) *The Vital Edge,* 1994, Videotape, Fish and Wildlife Services, Alberta Environmental Protection

G. Coal Hazard Lands

(1) *ERCB Coal Mine Atlas - Operating and Abandoned Coal Mines in Alberta ERCB 85-45* [ERCB is now the AEUB - Alberta Energy and Utilities Board]

(2) *General Guidelines for the Development of Lands in the Vicinity of Coal Hazards in Alberta* (draft) available from the Standards and Guidelines Branch, Alberta Environmental Protection (Edmonton, 427-8475)

H. Contaminated Sites

(1) *Alberta Tier 1 Criteria for Contaminated Soil Assessment and Remediation* - available from the Contaminated Sites and Decommissioning Branch (Edmonton, 427-6182)

(2) *Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites, Vols. 1 and 2.* CCME-EPC-NCS62E and NCS66E.

(3) *Interim Canadian Environmental Quality Criteria for Contaminated Sites.* CCME-EPC-CS34.

(4) *Phase 1 Environmental Site Assessment - Environmental Technology - A CSA Information Product. 1*994, Canadian Standards Association

(5) *Subsurface Assessment Handbook for Contaminated Sites.* CCME-EPC-NCSRP-48E

I. Intensive Livestock Operations

(1) *Code of Practice For the Safe and Economic Handling of Animal Manures* prepared in consultation with the livestock industry by Alberta Agriculture, Food and Rural Development and may be obtained from the Policy Secretariat, Alberta Agriculture, Food and Rural Development (Edmonton, 427-5359)

(2) *Development of Intensive Livestock Operations - Screening for Environmental Sensitivity Reference Manual* prepared in consultation with the livestock industry by Alberta Agriculture, Food and Rural Development and may be obtained from the Policy Secretariat, Alberta Agriculture, Food and Rural Development (Edmonton, 427-5359)

(3) *Development Permitting Process for Intensive Livestock Operations (ILOs)* prepared in consultation with the livestock industry by Alberta Agriculture, Food and Rural Development and may be obtained from the Policy Secretariat, Alberta Agriculture, Food and Rural Development (Edmonton, 427-5359)

J. Other Guidelines, Criteria and Publications

(1) *AEUB Oilfield Waste Management Requirements* available from Alberta Energy and Utilities Board (AEUB) Information Services Department (Calgary, 297-8190)

(2) *A User Guide to Pit & Quarry Reclamation in Alberta* 1992 available from the Conservation and Reclamation Review Branch (Edmonton, 422-2636)

(3) *Conservation and Logging on Private Land in Alberta* 1994 available from Alberta Agriculture, Food and Rural Development (Edmonton, 427-5570)

(4) *Design Guidelines and Specifications - Pesticide Container Collection Sites* December, 1988 available from the Pesticides Management Branch (Edmonton, 427-5855)

(5) *Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products* August 1994 CCME-EPC-LST-71E

(6) *Environmental Code of Practice for Underground Storage Tank Systems Containing Petroleum Products and Allied Petroleum Products* 1993 CCME En108-3/1-61E

(7) *Environmental Reference Manual for the Review of Subdivisions in Alberta* November, 1996 prepared by the Standards and Guidelines Branch, Alberta Environmental Protection and available from the Information Centre – Alberta Environmental Protection (Edmonton, 422-2079)

(8) *Fisheries Habitat Protection Guideline #6 – Timing Constraints In and Around Watercourses*

(9) *Guide for Pits* 1995 available from the Conservation and Reclamation Review Branch (Edmonton, 422-2636)

(10) *Guidelines for Industrial Landfills* June, 1987 available from the Industrial Waste Branch (Edmonton, 427-5847)

(11) *Guidelines for the Location of Stationary Bulk Ammonia Storage Facilities* available from the Air Emissions Branch, Alberta Environmental Protection (Edmonton, 427-5872)

(12) *Hazardous Waste Storage Guidelines* June, 1988 available from the Industrial Waste Branch (Edmonton, 427-5847)

(13) *Municipal Environmental Assessment A Land Use Planning Tool* April 1996 - A Discussion Paper prepared by the Alberta Association, Canadian Institute of Planners

(14) *Remediation Guidelines for Petroleum Storage Tank Sites* -1994-Draft - available upon request from the Groundwater Protection Branch (Edmonton, 427-6333)

(15) *Shooting Range Guidelines for Province of Alberta* jointly produced by Alberta Justice and Natural Resources Service, Alberta Environmental Protection; available from the Office of the Chief Provincial Firearms Officer, *Regulatory* and Administrative Support Branch, Alberta Justice (Edmonton, 427-0437)

(16) *Stormwater Management Guidelines* (April 1988) available from the Municipal Water and Wastewater Branch (Edmonton, 415-1860)

(17) Subdivision *and Development Regulation Requirements for Referrals to the Alberta Energy and Utilities Board* (AEUB - IL 95-07) Alberta Energy and Utilities Board

K. Internet Sites

i. Getting Started on the Internet – a Web Tutorial

(1) Microsoft Internet Explorer Web Tutorial
.....http://www.msn.com/tutorial/default.html

ii. Environment: Internet Starting Points

(1) Amazing Environmental Organisation Web Directory
.....http://www.webdirectory.com/

(2) Best Environmental Directories
..... http://www.ulb.ac.be/ceese/cds.html

(3) EcoNet ..... http://www.igc.org/econet/index.html

(4) EcoWeb ..... http://community.web.net/ecoweb/index.html

(5) EnviroLink .....http://www.envirolink.org/

(6) Enviro-Net ..... http://www.enviro-net.com/

(7) Environmental Sites on the Internet (Royal Institute of Technology Library - Stockholm, Sweden)
..... http://www.lib.kth.se/~lg/envsite.htm

(8) Environment Sources on the World Wide Web (The Institute of Earth Studies, University of Wales)
.....http://www.aber.ac.uk/~ieswww/geores/environ.html

(9) Galaxy - Environment
http://www.einet.net/galaxy/Community/Environment.html

(10) Geodata Information Sources (University of Iowa Center for Global and Regional Environmental Research)
http://www.cgrer.uiowa.edu/servers/servers_geodata.html

(11) Internet Resources for the Environmental Scientist
.....http://www.imt.net/~dcouncil/env.html

(12) The Climate/Weather/Earth Hotlist
..... http://space.rice.edu/~rss/hotlist.html

(13) The Green Lane on the Information Highway (Environment Canada)
.....http://www.ec.gc.ca/envhome.html

(14) The GW Green University Initiative
..... http://www.gwu.edu/~greenu/

(15) World Wide Web Virtual Library - Environment
.....http://earthsystems.org/Environment.shtml

(16) Yahoo - Environment and Nature
http://www.yahoo.com/Society_and_Culture/Environment_and_Nature/

iii. World

(1) The International Local Government Home Page
..... http://world.localgov.org/
North America .....http://world.localgov.org/northam.html

(2) UNEP - The United Nations Environment Programme
.....http://www.unep.org/

(3) WHO - World Health Organisation.....http://www.who.ch/

(4) WMO - World Meteorological Organisation .....http://www.wmo.ch/

iv. U.S. Sites

(1) EPA - U.S. Environmental Protection Agency .....http://www.epa.gov/

(2) Montana Natural Resource Information System.....http://nris.mt.gov/

(3) NGDC - U.S. National Geophysical Data Centre
.....http://www.ngdc.noaa.gov/

(4) NOAA - U.S. National Oceanic and Atmospheric Administration
..... http://www.esdim.noaa.gov/

(5) USGS - U.S. Geological Survey ..... http://www.usgs.gov/
Earth and Environmental Science
.....http://www.usgs.gov/network/science/earth/earth.html
USGS by Themes (hazards, resources, environment, information management) .....http://www.usgs.gov/themes/

v. Canada

(1) Canadian Almanac's Canada Info..... http://www.canadainfo.com/

(2) CCME - Canadian Council of Ministers of the Environment
..... http://www.mbnet.mb.ca/ccme/

(3) CMHC - Canada Mortgage and Housing Corporation
.....http://www.cmhc-schl.gc.ca/cmhc.html

(4) Canadian Legal Resources.....http://gahtan.com/lawlinks/

(5) Canadian Universities
.....http://www.gtn.net/canauniv.htm

(6) CanSIS - Canadian Soil Information System
..... http://res.agr.ca/CANSIS/

(7) CIP - Canadian Institute of Planners .....http://www.cip-icu.ca/

(8) EMAN - Ecological Monitoring and Assessment Network
.....http://CS715.cciw.ca/eman-temp/intro.html

(9) Environment Canada: About.....http://www.ec.gc.ca/whoeng.html
The Green Lane on the Information Highway
.....http://www.ec.gc.ca/envhome.html

(10) GORP - Great Outdoor Recreation Pages - Canada
.....http://www.gorp.com/gorp/location/canada/canada.htm

(11) Government of Canada .....http://canada.gc.ca/

(12) ICURR - Intergovernmental Committee on Urban and Regional Research
.....http://www.web.net/icurr/

(13) NRCan - Natural Resources Canada
..... http://www.nrcan.gc.ca/homepage/toc_e.shtml
CCRS - Canadian Centre for Remote Sensing Home Page
.....http://www.ccrs.nrcan.gc.ca/ccrs/homepg.pl?e
GSC - Geological Survey of Canada
.....http://www.nrcan.gc.ca/gsc/gschp.html
Terrain Sciences Division ..... http://sts.gsc.nrcan.gc.ca/tsd.htm
Geomatics Canada..... http://www.geocan.nrcan.gc.ca/
Geomatics Canada - National Atlas Information Service
.....http://www-nais.ccm.nrcan.gc.ca/
Canada's Official Geographical Names Web site (English)
..... http://geonames.nrcan.gc.ca/english/
Defacto - Geographical Facts
.....http://www-nais.ccm.nrcan.gc.ca/defacto/Home.html
National Atlas on SchoolNet
..... http://www-nais.ccm.nrcan.gc.ca/schoolnet/Home.html

(14) Parks Canada ..... http://parkscanada.pch.gc.ca/parks/main_e.htm

(15) Statistics Canada..... http://www.statcan.ca

(16) The Canadian Association of Petroleum Producers
..... http://www.capp.ca/

(17) The Coal Association of Canada.....http://testweb.alberta.com/~coalftp/

vi. Other Provinces and Territories - Environment Departments

(1) British Columbia Ministry of Environment, Lands and Parks
..... http://www.env.gov.bc.ca/

(2) Manitoba Environment.....http://www.gov.mb.ca/environ/

(3) New Brunswick Environment Department
..... http://www.gov.nb.ca/environm/index.htm

(4) Newfoundland and Labrador - Environment and Labour
.....http://www.gov.nf.ca/env/

(5) Northwest Territories – Resources, Wildlife and Economic Development
..... http://pingo.gov.nt.ca/Phone/Dept/dept0018.htm

(6) Nova Scotia Department of the Environment
.....http://www.gov.ns.ca/envi/

(7) Ontario Ministry of Environment and Energy
..... http://www.ene.gov.on.ca/

(8) Prince Edward Island Technology and Environment
..... http://www.gov.pe.ca/te/index.asp

(9) Quebec - Environnement et Faune ..... http://www.mef.gouv.qc.ca/en/

(10) Saskatchewan Environment and Resource Management
..... http://www.gov.sk.ca/govt/environ/

(11) Yukon Renewable Resources (no Web site established yet)

vii Alberta

(1) AAMD&C - Alberta Association of Municipal Districts & Counties
http://www.health-in-action.org/arpa/recalta.htmls/aamdc.html

(2) ACA - Alberta Conservation Association Contact Information
..... http://www.misltd.com/client01/contact.htm

(3) AEUB - Alberta Energy and Utilities Board Home Page
..... http://www.eub.gov.ab.ca

(4) AFGA - Alberta Fish and Game Association
..... http://www.afga.org/index.htm

(5) AGS - Alberta Geological Survey Home Page
..... http://hanbar.energy.gov.ab.ca/

(6) Alberta Agriculture, Food and Rural Development
..... http://www.agric.gov.ab.ca/index.html
SPERG - Services and Programs Electronic Retrieval for Government
..... http://www.agric.gov.ab.ca/sperg/index.html

(7) Alberta Ambient Air Data Management System (CASA)
..... http://www.ecotech.com

(8) Alberta Environmental Protection Home Page
..... http://www.gov.ab.ca/~env/index.html

(9) Alberta Forest Products Association ..... http://www.abforestprod.org/

(10) Alberta Law Centre ..... http://www.web.net/~elc/

(11) Alberta Municipal Affairs ..... http://www.gov.ab.ca/~ma/

(12) Alberta Research Council ..... http://www.arc.ab.ca/

(13) APEGGA - Association of Professional Engineers, Geologists & Geophysicists of Alberta http://www.apegga.com/

(14) ASPB – Alberta Society of Professional Biologists
.....http://www.ccinet.ab.ca/aspb/home.html

(15) AUMA - Alberta Urban Municipalities Association Home Page
..... http://www.auma.ab.ca/

(16) Environmental Services Association of Alberta ..... http://www.esaa.org

(17) Government of Alberta.....http://www.gov.ab.ca/
News Releases .....http://www.gov.ab.ca/acn.cfn

(18) NRCB - Natural Resources Conservation Board
.....http://www.gov.ab.ca/~nrcb/index.html

(19) Prairie and Northern Region (Green Lane on the Information Highway - Environment Canada).....http://www.mb.ec.gc.ca/ENGLISH/

(20) Queen's Printer Bookstore Home Page (catalogue, on-line text files of Alberta's laws and regulations, and other materials)
.....http://www.gov.ab.ca/qp/

(21) Telus Advertising Services – On-line Yellow Directories & Interactive Services .....http://www.alberta.com/

(22) The GATE - NEOS Libraries' Catalogue (access to holdings of numerous academic and government libraries)..... http://gate.library.ualberta.ca

(23) University of Calgary Library
..http://www.ucalgary.ca/UofC/departments/INFO/library/

viii. Conservation and Environment Organisations

(1) AEN - Alberta Environmental Network .....http://www.web.net/~aen/

(2) Canadian Nature Federation .....http://www.cfn.ca/

(3) C-PAWS - Canadian Parks and Wilderness Society
.....http://www.cpaws.org/

(4) Nature Conservancy ..... http://www.tnc.org/

(5) Sierra Club of Canada ..... http://www.sierraclub.ca/

(6) The Pembina Institute for Appropriate Development ..... http://www.piad.ab.ca

(7) WWF - World Wildlife Fund - Canada ..... http://www.wwfcanada.org/

ix. Sustainable Development

(1) Centre for Excellence for Sustainable Development ..... http://www.sustainable.doe.gov/

(2) Environmentally Sustainable Agriculture – Alberta Agriculture, Food and Rural Development http://www.agric.gov.ab.ca/navigation/sustain/about/index.html

(3) International Institute for Sustainable Development http://iisd1.iisd.ca/

(4) Solstice Internet Information Service of the Centre for Renewable Energy and Sustainable Technology (CREST) ..... http://solstice.crest.org/index.html

(5) Sustainable Earth Electronic Library ..... http://www.envirolink.org/pubs/

(6) United Nations Commission on Sustainable Development ..... http://www.un.org/esa/sustdev/

(7) World Resources Institute ..... http://www.wri.org/

(8) Worldwatch Institute ..... http://www.worldwatch.org/

x. Identifying Natural and Technological Hazards - Preparing for a Disaster

(1) Alberta Environmental Protection Advisories and Warnings on High Streamflows, Floods and Ice Jams ..... http://www.gov.ab.ca/~env/water/flood.html

(2) CEPPO - Chemical Emergency Preparedness and Prevention Office ..... http://www.epa.gov/swercepp/

(3) DRIE - Disaster Recovery Information Exchange ..... http://www.drie.org/

(4) FEMA - Federal (U.S.) Emergency Management Agency
Home Page ..... http://www.fema.gov/

(5) Geohazards - Selected References
..... http://www.aber.ac.uk/~jpg/hazards/hazsourc.html

(6) Government of Alberta News Releases (ACN Today - Alberta Communications Network)..... http://www.gov.ab.ca/acn.cfm

(7) ICES Disaster Resources - Preparedness and Recovery - University of Illinois .....http://www.ag.uiuc.edu:80/~disaster/prep.html

(8) Natural Disaster Reference Database (Earth Sciences Directorate, NASA, Goddard Space Flight Center)
..... http://ltpwww.gsfc.nasa.gov/ndrd/ndrd1.html

(9) Natural Hazards Center at the University of Colorado, Boulder
..... http://www.Colorado.EDU/hazards/

(10) Simon Fraser University, British Columbia, Canada
Emergency Preparedness Canada..... http://hoshi.cic.sfu.ca/~epc/
EPIX - Emergency Preparedness Information Exchange
.....http://hoshi.cic.sfu.ca/epix
HazardNet Informational Subsystem
http://hoshi.cic.sfu.ca/~hazard/INFORMAT/informat.html

(11) U.S. Army Corps of Engineers.....http://www.usace.army.mil/

(12) U.S. Geological Survey -
Central Region Geologic Hazards ..... http://geohazards.cr.usgs.gov/
Hazards Theme Page ..... http://www.usgs.gov/themes/hazard.html

xi. Slope Movement Hazards

(1) Geotechnical Engineering, University of Alberta
.....http://www.civil.ualberta.ca/geot/GEOTHOME.HTM

(2) Landslides and Snow Avalanches in Canada
..... http://sts.gsc.emr.ca/page1/geoh/slide.htm

(3) Landslides, Debris Flows, and Slope Stability – Geologic Investigations
.....http://quake.wr.usgs.gov/CALHAZ/dldhaz.html

(4) Landslides in British Columbia
http://www.ei.gov.bc.ca/geosmin/mapinv/surfical/landslid/lshome.htm

(5) The Virtual Library of Geotechnical Engineering
..... http://geotech.civen.okstate.edu/wwwvl/index.htm

xii. Contamination - General

(1) Canadian Council of Ministers of the Environment
..... http://www.mbnet.mb.ca/ccme/

(2) Global Network of Environment and Technology
.....http://www.gnet.org/

xiii. Environmental Chemicals and Pathogens

(1) ATSDR - Agency for Toxic Substances and Disease Registry including access to the Hazardous Substance Release/Health Effects Database (HazDat) and ToxFAQs http://atsdr1.atsdr.cdc.gov:8080/atsdrhome.html

(2) CDC - Centers for Disease Control and Prevention in Atlanta
..... http://www.cdc.gov/

(3) CEPPO - Chemical Emergency Preparedness and Prevention Office
..... http://www.epa.gov/swercepp/

(4) EXTOXNET - The EXtension TOXicology NETwork - Pesticides
.....http://ace.orst.edu/info/extoxnet/

(5) Hazardous Chemical Database - University of Akron
.....http://ull.chemistry.uakron.edu/erd/

(6) Material Safety Data Sheets (MSDS) - Links to various MSDS web sites
..... http://www.phys.ksu.edu/~tipping/msds.html

(7) OPPT Chemical Fact Sheets - Chemicals in the Environment
.....http://www.epa.gov/chemfact/

(8) NIST Chemistry WebBook (National Institute of Standards & Technology)
..... http://webbook.nist.gov/chemistry/

(9) NLM - U.S. National Library of Medicine Medlars and Toxnet Systems
.....http://www.nlm.nih.gov/databases/medlars.html

(10) NTP - National Toxicology Program .....http://ntp-server.niehs.nih.gov/

(11) Enviro-Net - Material Safety Data Sheet (MSDS) Index
..... http://www.enviro-net.com/technical/msds

(12) Envirofacts Warehouse and Chemical References
. http://www.epa.gov/enviro/html/emci/chemref/index.html

xiv. Water Related

(1) Alberta Environmental Protection – Water Related
..... http://www.gov.ab.ca/env/water.html

(2) Canadian Centre for Inland Waters .....http://www.cciw.ca/
Environment Canada - A Primer on Fresh Water
http://www.ec.gc.ca/water/en/info/pubs/primer/e_contnt.htm
National Water Research Institute
..... http://www.cciw.ca/nwri-e/intro.html

(3) Canadian Heritage Rivers - Parks Canada
.....http://parkscanada.pch.gc.ca/rivers/chrs_e.htm

(4) Canadian Water Resources Association
.....http://www.cwra.org/

(5) CMC - Canadian Meteorological Centre
..... http://www.cmc.ec.gc.ca/indexe.html
Canadian Climate and Water Information and Data Site
.....http://www.cmc.ec.gc.ca/climate/

(6) Ducks Unlimited Canada..... http://www.ducks.ca/

(7) FDR - Flood Damage Reduction - Prairie and Northern Region -Environment Canada http://www.mb.ec.gc.ca/ENGLISH/WATER/FDR/

(8) Fundamentals of Groundwater Contamination
.. http://nesen.unl.edu/csd/illustrations/ec11/ec11text.html

(9) Limnology of the Okanagan Lakes
http://oksw01.okanagan.bc.ca/fwsc/oklimnol/oklimnol.html

(10) NALMS - North American Lake Management Society
.....http://www.nalms.org/
ALMS - Alberta Lake Management Society
.....http://www.nalms.org/chapters/chapters.htm

(11) Nitrates in the Nation's Groundwaters
..... http://www.wvu.edu/~agexten/v1i5/nitrates.htm

(12) Trout Unlimited..... http://www.tu.org/index.html

(13) Water Resources Engineering - University of Alberta
.....http://www.civil.ualberta.ca/water/

(14) Water Resources Center Library Bookmarks
http://www.library.wisc.edu/libraries/Water_Resources/

Appendix H - Preparation of a Base Map

A. *Introduction*

For subdivision applications, good maps should show exactly what is proposed and its relationship with its natural and built (human made) environment. Different kinds of subdivision maps are described in detail in Appendix D of the *Environmental Reference Manual for the Review of Subdivisions in Alberta* November, 1996 (Appendix G, Section J.).

This appendix concentrates on how to create a base map (Section C.), which is very similar to the topographic tentative plan map described in the above mentioned manual. The Base Map should be used:

- for more complex multiparcel subdivisions where the site exhibits physical variability, especially with respect to topography and water table conditions (Appendix F - Water Table); and
- when a subdivision authority requires an applicant to provide environmental information pursuant to Subsection 4(5) of the *Subdivision and Development Regulation, Municipal Government Act*; and
- when the environmental information requested by the subdivision authority entails the use of one or more environmental guidelines that require preparation of a base map.

B. *Requirements for Mapping - Subdivision and Development Regulation*

Sketches, plans and maps assist the subdivision authority to determine whether the land that is proposed to be subdivided is suitable for the purpose for which the subdivision is intended (refer to 654(1)(a) of the *Municipal Government Act*; refer to Appendix A, Section I. of this document).

Subsection 4(4) of the *Subdivision and Development Regulation, Municipal Government Act* describes minimum mapping requirements for subdivision applications (Appendix B, Section B.). For most subdivision applications these mapping requirements will likely be sufficient. For more complex subdivision proposals, a subdivision authority may need environmental reports and associated mapping to make an informed decision on the application. The subdivision authority is entitled to require an applicant for subdivision to submit, besides a complete application for subdivision, reports and maps pursuant to Subsection 4(5) of the *Subdivision and Development Regulation* (Appendix B, Section C.). Subsection 4(5) is complemented by Section 7 of the Regulation. This section requires that a subdivision authority, in deciding whether to approve a subdivision application,

must consider, various natural and human made features of the subject land and the use of neighbouring land. (Appendix B, Section D.).

C. *Creating the Base Map*

i. Purpose of the Base Map

The purpose of the Base Map is to display for planning purposes the Proposed Subdivision Area and tentative plan superimposed on significant natural and human made features within the site. Usually, the Base Map does not have to be prepared to engineering standards. This would entail considerably greater accuracy and expense. When the Base Map is completed, other information such as test hole locations, generated by using the environmental guidelines can be superimposed easily on it.

ii. Overview of Resources Available for Base Map Preparation

Section D. of this appendix presents a detailed list of sources of information for mapping and site investigations. Additional information may be obtained from municipal maps, existing subdivision plans, and site inspections.

One of the most useful resources for Base Map preparation and site studies is stereo aerial photographs (stereo air photos – refer to Section D., Items 8, 11 and 13). Use of these air photos with a stereoscope permits a viewer to examine in detail the site in three dimensions (3-D). Section E. explains the procedure for looking at stereo air photos with a pocket stereoscope.

iii. Base Map Area

Ensure the Base Map encompasses the Proposed Subdivision Area, and any neighbouring areas that contain features that may potentially pose a potential hazard or constraint to the proposed development due to flooding, erosion, high water table conditions, slope instability, undermining and subsidence, contamination, etc.

iv. General Attributes of the Base Map

Ensure that the Base Map:

- contains a north arrow;
- is oriented such that north is at the top of the page unless the shape of the area favours other orientations;
- has a scale in the 1:1,000 to 1:2,000 range;
- delineates and labels the Proposed Subdivision Area and the proposed lots;
- displays all section numbers; and

- has a legend that includes:
  - the legal description of the titled area (quarter section, township, range, meridian, and if applicable, lot, block and plan)
  - municipality name
  - map scale (e.g. 1:2,000)
  - if applicable, information on air photos used to derive information (date, scale, AS number and photo numbers)
  - subdivision authority (SA) and SA file number
  - date drawn and name of persons or group that prepared the map.

v. Topographic Information on the Base Map

(1) Topographic Contours

Depict the relief on the Base Map by means of topographic contours at not greater than 1.5 metre (5 foot) intervals. Derive these contours from air photos or ground surveys (photos should be the most recent available of appropriate scale). Tie the contours into a geodetic datum where practicable.

(2) Measuring Slopes in Forested Areas

Making accurate contour maps is difficult in forested areas. Using stereo air photos, the photogrammetrist can only see the upper surface of the tree canopy and not the underlying ground surface. Since the canopy surface is a subdued reflection of the underlying ground surface, small valleys literally disappear and valley sides appear less steep. To overcome this problem and increase the accuracy and usefulness of the map, a site inspection by a surveyor is very desirable.

The surveyor should physically travel the forested portion of the site with the contour map in hand measuring the ground surface slopes at many locations with a hand held clinometer. The surveyor should then superimpose these slope measurements on the contour map.

(3) Delineating Areas with Slopes Exceeding 15%

Delineate all areas within the site with slopes exceeding 15% using information gathered above.

vi. Supplementary Cultural and Physical Features

(1) Linear Developments and Buildings

Delineate and label all major linear developments (railways, roads, transmission lines (> 69 kv), etc.) and buildings within the map area.

(2) Water Features

Delineate and label water features within the map area including:

- natural water bodies (lakes, sloughs)
- reservoirs or other impoundments
- natural water courses (creeks, streams, rivers, etc.)
- canals or drainage ditches
- flood protection dykes

(3) Other Natural Features

Delineate and label other natural features including:

- all mountain sides within the map area
- areas that have numerous hills
- the crest and toe of slope of banks.
- vegetation boundaries associated with forests, grasslands, cultivated fields and wetlands (bogs, fens, low lying water body margins, etc.)
- soil capability for agriculture using Canada Land Inventory (C.L.I.) or farmland assessment

(4) Environmentally Significant Areas

Delineate and label Environmentally Significant Areas (Appendix F) as identified in existing municipal Environmentally Significant Areas studies.

vii. Possible Use of an Air Photo Background

Sometimes a site exhibits substantial physical variability (topography, water table conditions, hydrography, vegetation, etc.) and the proposed subdivision is complex. In this situation, consider adding to the Base Map an uncorrected air photo background enlarged to approximately the same scale. Since this map is for planning purposes, an orthophoto, which is a geocorrected image true to scale, is not necessary. Utilize the same photographs used to generate the contours for the background.

D. Sources of Information for Mapping and Site Investigations

NOTE: TOLL FREE CONNECTION TO PROVINCIAL GOVERNMENT OFFICES
For information and assistance in completing calls to provincial government offices, private callers within Alberta can phone toll free the Regional Information Telephone Enquiry RITE Number 310-0000.

INDEX OF PRODUCTS AND SERVICES

Type of Product	**Possible Sources** (see next pages)
• Air Photos	8, 11, 13
• Atlases	
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Atlas of Alberta Lakes	2, 11
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• Digital Products	
geodetic survey markers	4, 6
cadastral mapping	4
provincial digital base maps	4
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thematic mapping	6
topographic information	4, 6
• Land Titles	19
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Canada Land Inventory (CLI)	2, 11
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silica sands	2, 10
soils	2, 5, 14
stream flow	7
surficial geology	2, 10
topography	3, 6, 8, 11
water quality (lakes, reservoirs, streams)	7
• Publications Catalogue/Lists	1, 2, 5, 9, 10, 14
• Satellite Images	6, 15, 18

(1) AEUB DISTRIBUTION CENTRE
Information Services Department
Alberta Energy and Utilities Board (AEUB)
640 - 5th Ave S.W.
Calgary AB T2P 3G4 ..... Phone 297-8190
..... Fax 297-7040
Internet - [AEUB Home Page]
..... http://www.eub.gov.ab.ca

Products -

- AEUB maps and charts (oil, gas and pipeline maps, coal maps, electricity maps, geological maps and charts, regional maps)
- Reports, Information Letters (ILs), Interim Directives (IDs), and General Bulletins (GBs)

(2) ALBERTA ENVIRONMENTAL PROTECTION LIBRARY
Alberta Environmental Protection
6th Floor, 9920 - 108 Street
Edmonton, AB T5K 2M4 ..... Phone 427-5870
..... Fax 422-0170
..... Email library@env.gov.ab.ca
.. Internet - [The GATE - NEOS Libraries' Catalogue]
..... http://gate.library.ualberta.ca

Products -

- The library contains over 50,000 books and reports and subscribes to 700 journals and newsletters. The library lends its materials to consultants, students and the general public.
- The collection covers a wide range of scientific and technical subjects including: biological diversity, civil and chemical engineering, environmental impact assessment, environmental law, fisheries, forestry, geology and geography, natural areas, oil sands, parks, pollution, soil science, waste management, water resources, wildlife.
- The collection has a number of reports pertaining to lakes – look for reports with titles containing keywords: Alberta, angler, creel, ecological inventory of shoreline, fish (fishery, fisheries, fishing), integrated management plan, integrated resource inventory, lake, lake hydrological study, lake management plan, lake shoreland biophysical inventory and land use evaluation, lake shoreline habitat assessment, lake stabilization study, lake survey, lake water quality study, limnological survey, soil survey and land suitability evaluation, stocking, water management project
- The collection is the depository of all released department reports.

(3) CANADA MAP OFFICE
130 Bentley Road
Ottawa, Ontario K1A 0E9.....Phone toll free 1-800-465-6277
.....Email info@GeoCan.NRCAN.gc.ca.
Internet - [Canada Map Office Home Page]
http://www.GeoCan.NRCan.gc.ca/busdev/serv/cmoe. html

Products -

- National Topographic Series (NTS) Maps

(4) CLIENT SERVICES BRANCH - RESOURCE DATA DIVISION
Alberta Environmental Protection
12th Floor, Oxbridge Place
9820 - 106 Street NW
Edmonton, AB T5K 2J6 ..... Phone 427-7374
.....Fax 422-0973

Products -

- Alberta digital products data distribution (wide variety of surveying and mapping products)

(5) CONSERVATION AND DEVELOPMENT BRANCH
Alberta Agriculture, Food and Rural Development
206, JG O'Donoghue Building
7000 - 113 Street
Edmonton, AB T6H 5T6..... Phone 422-4385
.....Fax 422-0474

Products and Services -

- advice on digital products
- assist in the selection of soil survey products
- assist in understanding soil survey maps and reports
- publications list

(6) GEOMATICS INFORMATION CENTRE
615 Booth Street
Ottawa, Ontario KIA 0E9 .....Phone (613) 995-4321
..... Fax (613) 943- 1549
Internet [Geomatics Canada Home Page]
..... http://www.geocan.nrcan.gc.ca/

Products and Services -

- Digital Products (aeronautical charts, geodetic survey, remote sensing, thematic mapping, topographic information)
- Conventional Products (aeronautical charts, remote sensing, thematic maps, topographic information
- Services, Publications and Software
- Geomatics Canada - Main Information Desk

(7) GROUNDWATER AND SURFACE WATER INFORMATION
Water Data Management Section
Water Sciences Branch
Alberta Environmental Protection
10th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, AB T5K 2J6

Groundwater ..... Phone 427-2770
Surface Water ..... Phone 427-6278

Groundwater Products -

- aquifer test reports prepared by groundwater consulting companies for the evaluation of specific projects
- flowing shot hole reports
- geophysical logs
- provincial observation well network information
- Reconnaissance Lists (list of water wells in the vicinity of a specific location)
- water well chemistries
- Water Well Driller's Reports
- *Water Wells that last for generations* 1998 Joint publication by Agriculture Canada, Alberta Agriculture, Food and Rural Development, and Alberta Environmental Protection

Surface Water Products (lakes, ponds, reservoirs, rivers, creeks, etc.) -

- *Alberta Lakes and Reservoirs Reference Index* 1996 – Alberta Environmental Protection
- lake and reservoir water levels
- lake and reservoir water quality information (Numerous water bodies in the database have water chemistries obtained from composite and profile sampling. Commonly measured parameters include pH, turbidity, true colour, biochemical oxygen demand, and concentrations of various cations and anions. These parameters can be used to establish among other things the productivity (trophic category) of the water body. Also, typically there are bacteriological data that provide information on possible contamination

of the water body by human or livestock wastes. Occasionally, water chemistries will include analyses of metals and/or organics (herbicides and pesticides).

- stream water flow and water quality information

(8) INFORMATION CENTRE - AIR PHOTO SERVICES
Alberta Environmental Protection
Main Floor, 9920 - 108 Street
Edmonton, AB T5K 2M4 ..... Phone 427-3520
.....Fax 422-9683

Products -

- diazo (black and white) provincial maps
- provincial air photos
- lake and reservoir hydrographic charts (also called bathymetric maps, 93 maps available)

(9) INFORMATION CENTRE - ALBERTA ENVIRONMENTAL PROTECTION
Main Floor, 9920 - 108 Street
Edmonton, AB T5K 2M4 ..... Phone 422-2079
.....Email infocent@env.gov.ab.ca

Products -

- distributes departmental publications
- publications list

(10) INFORMATION SALES - ALBERTA GEOLOGICAL SURVEY (AGS)
Alberta Energy and Utilities Board
7th Floor Petroleum Plaza, North Tower
9945 - 108 Street
Edmonton, AB T5K 2G6 ..... Phone 422-3767
.....Fax 422-1918
.....Email protz@enr.gov.ab.ca
Internet [Alberta Geological Survey Home Page]
..... http://hanbar.energy.gov.ab.ca/ags/ags1/ags.html

Products -

- Geological Maps and Reports (aggregate resources, bedrock geology and topography, drift thickness, glacial geology, hydrogeology, mineral resources, oil sands, regional coal mapping, silica sands, surficial geology)
- publications list

(11) LOCAL AUTHORIZED MAP DEALERS - look under Maps in your Yellow Pages

Products -

- air photos
- map accessories such as grid overlays
- Selection of maps varies with individual dealer but may include National Topographic Series (NTS) Maps, lithographed and diazo provincial maps, lake and reservoir hydrographic charts (also called bathymetric maps, 93 maps available)

(12) MANITOBA REMOTE SENSING CENTRE (MRSC)
Land Information Division
Manitoba Natural Resources
1007 Century Street
Winnipeg, MB R3H 0W4 ..... Phone (204) 945-6597
..... Fax (204) 945-1365

Products and Services -

- conducts digital image processing of satellite data for resource studies, inventorying, and environmental monitoring
- consulting, research and development, education, technology transfer, provision of satellite imagery, thematic land cover maps, joint venture opportunities, and rental of equipment

(13) NATIONAL AIR PHOTO LIBRARY (NAPL)
615 Booth Street
Ottawa, Ontario KIA 0E9 ..... Phone 1-800-230-6275
..... Fax (613) 995-4568

Products -

- NAPL has over 4.5 million air photos covering all of Canada, some dating as far back as the 1920's.

(14) PUBLICATIONS OFFICE
Alberta Agriculture, Food and Rural Development
JG O'Donoghue Building
7000 - 113 Street
Edmonton, AB T6H 5T6 ..... Phone 427-0391 or 1-800-292-5697

Products -

- detailed reconnaissance, reconnaissance and exploratory soil surveys
- digital soil survey products
- publications list
- small scale provincial maps

(15) RADARSAT INTERNATIONAL INC. (RSI)
Building D, Suite 200
3851 Shell Road
Richmond, BC V6X 2W2 ..... Phone (604) 244-0400
..... Fax (604) 244-0404
Internet http://www.ccrs.emr.ca/gcnet/query/lsat_od_e.html

Satellite Imagery Products for Commercial Clients -

- LANDSAT (MSS/TM)
- SPOT (PLA/MLA)
- radar products - ERS-1 SAR, J-RES - 1, RADARSAT

(16) RESOURCE DATA DIVISION
Alberta Environmental Protection
12th Floor, Oxbridge Place
9820 - 106 Street NW
Edmonton, AB T5K 2J6 ..... Phone 422-3476

Products -

- Environmentally Significant Areas Studies

(17) RIVER ENGINEERING BRANCH
Alberta Environmental Protection
9th Floor, Oxbridge Place
9820 - 106 Street NW
Edmonton, AB T5K 2J6 ..... Phone 427-6280
.....Fax 426-2343

Products -

- floodplain studies

(18) SATELLITE OPERATIONS CENTRE, CLIENT SERVICES
Canadian Centre for Remote Sensing (CCRS)
588 Booth Street
Ottawa, Ontario K1A 0Y7.....Phone (613) 990-8033
..... Fax (613) 991-5538
Internet - [Canadian Centre for Remote Sensing Home Page]
..... http://www.ccrs.nrcan.gc.ca/ccrs/homepg.pl?e

Services -

- Alberta companies offering remote sensing services - refer to CCRS Home Page under "The Remote Sensing Community": companies
- Commercial clients such as municipalities and consultants can purchase satellite imagery products from Radarsat International Inc.
- General information on remote sensing, products and companies

(19) SURVEYS
Alberta Registries - Land Titles Office
Mezzanine and 3rd fl, John E. Brownlee Building
10365 - 97 Street
Edmonton, AB T5J 3W7..... Phone 427-7005
.....Fax 429- 4885

Alberta Registries - Land Titles Office
Main fl, John J. Bowlen Building
620 - 7 Avenue SW
Calgary, AB T2P 0Y8 ..... Phone 297-5099
.....Fax 297-6528

Product and Services

- land titles information

E. How to Look at Stereo Aerial Photographs with a Pocket Stereoscope

An aerial photograph (air photo) is a photograph taken of a portion of the earth's surface by a camera mounted in a fixed wing aircraft. A large scale air photo covers a relatively small area (e.g. 1:5,000; or 1 cm on a photo = 50 metres on the ground), whereas a small scale photo encompasses a relatively large area (e.g. 1:60,000; 1 cm on a photo = 600 metres on the ground). A key feature of aerial photography is that each photo overlaps the previous frame by at least 60%. Since the overlapping area has been photographed from two different angles, common areas within adjacent photos can be viewed with a stereoscope in stereo or 3-D. Described below is a procedure for viewing adjacent air photos with a pocket stereoscope (stereoscope suppliers may be found in the Yellow Pages under Drafting Room Equipment and Supplies, or Surveying Instruments - see either the phone book or Telus Advertising Services' website – On-line Yellow Directories & Interactive Services http://www.alberta.com/).

1. Select adjacent air photos (e.g. air photos #'s 32 & 33) that both contain the site of interest, for example a farmstead.

2. Place these adjacent photos side by side such that the overlapping area of each is towards the centre or the inside. There should now be a left photo and a right photo.

3. Notice that the subject site is likely closer to the centre in one photo compared to the other. Slightly overlap the air photos so that the photo with the site closer to the centre is on top.

4. Align the photos. Ensure that top-bottom oriented lines or features are parallel, and left-right oriented lines or features are lying in the same straight line.

5. Without loosing alignment, carefully push the photos inwards until the subject site or other identical features are separated by 5 to 6 cm (slightly more than 2 inches).

6. Notice that the top photo likely covers the subject site. Place the pocket stereoscope on the photos while holding them down to maintain alignment. The stereoscope should have the same alignment as the air photos (see Step 4.) and be placed so that the left lens is above the subject site on the left photo. Similarly the right lens should be above the subject site on the right photo.

7. Look through the stereoscope while gently curling back the inner edge of the upper photo so that the subject site can be seen clearly on both photos. If the site is not in 3-D, carefully change the position of the stereoscope and/or push the photos further inwards or pull them outwards.